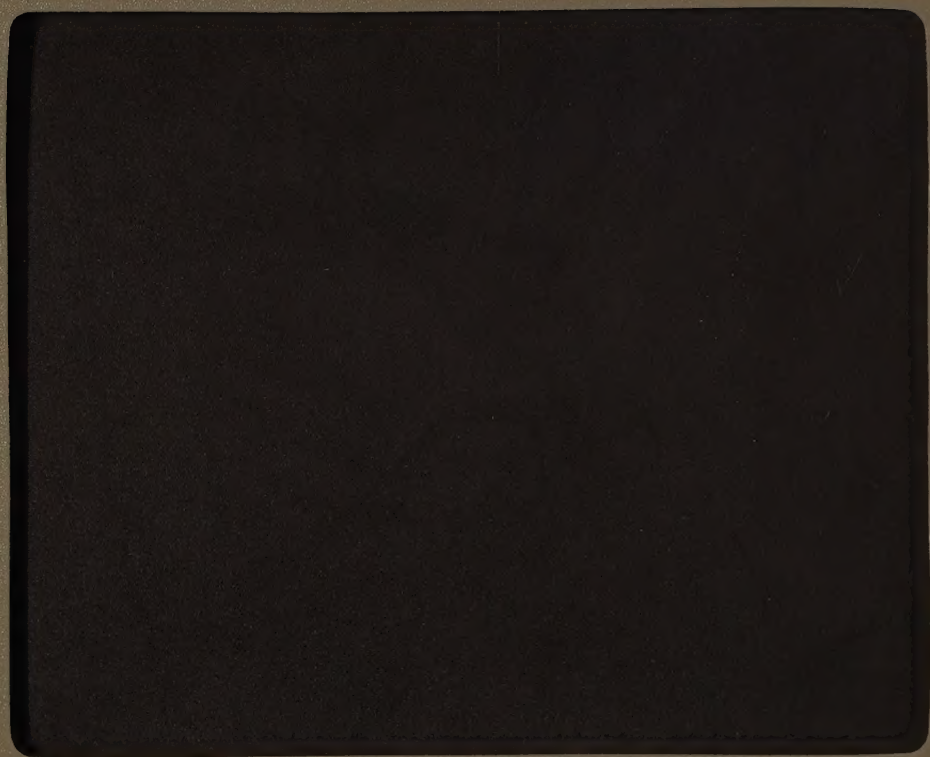




FLUKE®



2175A

Digital Thermometer

Instruction Manual

P/N 445478
April 1976
Rev. 1 2/77

MEGAwave inc.

2151-G O'Toole Ave.
San Jose, CA 95131-1314



WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90-days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 1 year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

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The JOHN FLUKE MFG. CO., INC., will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

*For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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Section 1

Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 2175A Digital Thermometer is a portable, four-digit, thermocouple thermometer capable of resolving 0.2°C or 0.2°F over a temperature range of -99.8 to 999.8°C or -99.8 to 999.8°F . It features push-button selection of $^{\circ}\text{C}$ or $^{\circ}\text{F}$, a four digit LED display, reference junction compensation (to eliminate the need for an ice-bath reference junction), the choice of using any one of four thermocouple types (J, K, E or T) as the input device, dual-slope measurement techniques and digital linearization of the thermocouple inputs. Several options and accessories are also available for use with the 2175A.

1-3. Push button controls include a power switch (ON/OFF), a temperature scale switch ($^{\circ}\text{C}/^{\circ}\text{F}$) and a charge switch (ON/OFF). When the unit is equipped with Ni-Cad batteries and is connected to line power, the charge switch (OFF) selects a trickle charge rate and simultaneous use of the instrument, or (ON) selects a fast charge rate but deactivates the instrument.

1-4. The front-panel display consists of five, seven-segment high-intensity LED's, and features leading-zero suppression. Four of the LED's are used to display numeric data, including a minus sign for negative temperature indications. The fifth LED displays the selected $^{\circ}\text{C}$ or $^{\circ}\text{F}$ scale character. An open-thermocouple detector causes the display to blink when an open circuit is sensed at the thermocouple input terminals.

1-5. Rear-panel, screw-type input connectors are provided for attaching the selected thermocouple. These terminals are an integral part of an isothermal block and serve as the reference junction for the reference-junction compensator. (The reference-junction compensator provides the physical and electrical equivalent of, and eliminates the need for, an ice bath reference junction at 0°C or 32°F .)

1-6. The actual measurement range of the 2175A is determined by the type of thermocouple being used as the input device. Any one of four thermocouple types can be used; J, K, E or T. To ensure the proper linearization of the selected thermocouple input, a corresponding linearization program must be selected on the interior of the unit. Selection is accomplished by installing a type-select pcb which corresponds to the input thermocouple. A single type-select pcb is supplied with the unit to match the thermocouple type specified at the time of purchase. The remaining pcb's are individually available as accessories and are described in Table 1-1.

Table 1-1. 2175A ACCESSORIES

MODEL NO.	DESCRIPTION
C80	Carrying Case
C86	Carrying Case
P20J	J-Type Thermocouple Probe
P20K	K-Type Thermocouple Probe
P20T	T-Type Thermocouple Probe
M00-100-714	Front Panel Dust Cover
M00-200-611	Rack Mounting Kit, Offset
M00-200-612	Rack Mounting Kit, Center
M00-200-613	Rack Mounting Kit, Side-by-Side
2160A-7016	J-Type Select PCB
2160A-7017	K-Type Select PCB
2160A-7019	E-Type Select PCB
2160A-7018	T-Type Select PCB
2160A-7022	Interface Cable

1-7. Accessories and Options available for use with the 2175A are listed and described in Table 1-1 and 1-2, respec-

tively. Detailed information concerning each option and accessory is given in Section 6 of this manual, Option and Accessory Information.

Table 1-2. 2175A OPTIONS

OPTION NO.	DESCRIPTION	COMPATIBILITY		
		-01	-02	-04
-01	Rechargeable Batteries	—	YES	YES
-02	Digital Output Unit	YES	—	NO
-04	Analog Output Unit	YES	NO	—

1-8. The 2175A is available in any one of three line power configurations: 100V ac, 50 to 440 Hz; 115V ac, 50 to 440 Hz; and 230V ac, 50 to 440 Hz. Specify the required configuraiton at the time of purchase.

1-9. SPECIFICATIONS

1-10. Specifications for the 2175A are given in Table 1-3.

Table 1-3. SPECIFICATIONS

ELECTRICAL

Compatible Thermocouple Types	Unit can be calibrated to operate with any one of the following thermocouple types: J, K, T, E
Measurement Method	Dual-slope integration over a 100 ms period
Zero Drift	None. Automatic zero correction
Reading Rate	2.5 readings per second
°C to °F Conversion	Switch selectable
Input Characteristics	
Input Connections	Screw terminals on isothermal connector
Input Circuit	Two-wire, isolated
Input Impedance	> 100 M Ω
Input Current	< 500 pA
Source Impedance	$\leq 5k\Omega$. $5k\Omega$ causes <0.2°C (36°F) error with k thermocouple
Overload	Display flashes when input voltage exceeds full-scale temperature range
Open Input	Display flashes to indicate open at input terminals
Maximum Input Voltage (without damage)	400V dc or ac peak continuously between inputs or between either input and ground
Maximum Common Mode Voltage (without damage)	400V dc or ac peak
Common Mode Rejection	≥ 120 dB @ 50, 60, 400 Hz $\pm 0.1\%$ with $1k\Omega$ source impedance unbalance
Normal Mode Rejection	≥ 60 dB @ 50, 60, 400 Hz $\pm 0.1\%$
Accuracy	See Table 1 for °C specifications and Table 2 for °F specifications
Response Time to Rated Accuracy	< 2.0 seconds
Linearization	Digital with four selectable programs in LSI ROM
Linearization Programs	
J, K, T and E	32 straight line segments for positive inputs and 16 for negative inputs

Table 1-3. SPECIFICATIONS (Cont.)

Reference Junction Compensation

20 to 30°C (68 to 86°F)

J, K, T, E 0.025 degrees per degree

0 to 20°C, 30 to 50°C (32 to 68°F, 86 to 122°F)

J, K 0.032 degrees per degree

T, E 0.045 degrees per degree

Temperature Coefficient 0.005% of reading per °C

Internal Temperature Rise $\leq 8^{\circ}\text{C}$ (14.4°F)

Table 1. ACCURACY SPECIFICATIONS °C

THERMOCOUPLE TYPE	TEMPERATURE RANGE °C	RESOLUTION AND REPEATABILITY (±°C)	APPLICABLE TEMPERATURE RANGE °C	MAXIMUM ERROR INCLUDING NBS CONFORMITY (±°C)*				NBS CONFORMITY (±°C)
				CALIBRATION ACCURACY	20 min. to 24 hrs. 23 to 27°C	90 Days 20 to 30°C	1 Year 15 to 35°C	
J	-99.8 to 777.8	0.2	-99.8 to 0 0 to 777.8	0.5	0.7	1	1.2	0.19
				0.4	0.5	0.7	1.1	0.15
K	-99.8 to 999.8	0.2	-99.8 to 0 0 to 999.8	0.7	0.8	1.2	1.5	0.2
				0.5	0.6	1.1	1.4	0.18
T	-99.8 to 400	0.2	-99.8 to 0 0 to 400	0.6	0.6	1	1.6	0.19
				0.4	0.5	0.6	0.9	0.15
E	-99.8 to 999.8	0.2	-99.8 to 0 0 to 999.8	0.6	0.7	1	1.7	0.17
				0.5	0.6	1	1.4	0.18

*Includes reference junction and conformity errors. Excludes thermocouple errors.

Table 2. ACCURACY SPECIFICATIONS °F

THERMOCOUPLE TYPE	TEMPERATURE RANGE °F	RESOLUTION AND REPEATABILITY (±°F)	APPLICABLE TEMPERATURE RANGE °F	MAXIMUM ERROR INCLUDING NBS CONFORMITY (±°F)*				NBS CONFORMITY (±°F)
				CALIBRATION ACCURACY	20 min. to 24 hrs. 72 to 81°F	90 Days 68 to 86°F	1 Year 59 to 95°F	
J	-99.8 to 999.8	0.2	-99.8 to 32 32 to 999.8	0.9	1	1.6	2.1	0.27
				0.7	0.8	1.2	1.6	0.2
K	-99.8 to 999.8	0.2	-99.8 to 32 32 to 999.8	1.1	1.2	2.0	2.6	0.28
				1	1	1.4	1.8	0.26
T	-99.8 to 752	0.2	-99.8 to 32 32 to 752	0.9	0.9	1.7	2.9	0.3
				0.6	0.8	1	1.5	0.2
E	-99.8 to 999.8	0.2	-99.8 to 32 32 to 999.8	0.9	0.9	1.7	3.0	0.25
				0.8	0.9	1.3	1.8	0.25

*Includes reference junction and conformity errors. Excludes thermocouple errors.

Table 1-3. SPECIFICATIONS (Cont.)

GENERAL

Type of Display	LED, 0.56 in high.
Power Requirements	
Line Operation	115V ac $\pm$ 10%, 50 to 440 Hz, 8W. 100V ac and 230V ac versions are also available.
Battery Operation	4.8V dc @ 350 mA (Four internal, D-size, Ni-Cad batteries, -01 option). Eight hours of operation on a full charge.
Size	2.52 in (H) x 8.55 in (W) x 9.9 in (D) (6,40 cm x 21,72 cm x 25,25 cm). See Figure 1-1.
Weight	
Without Batteries	2 lbs. 10 oz. (1.19 kg)
With Batteries	3 lbs. 15 oz. (1.79 kg)

ENVIRONMENTAL

Operating	0 to 50°C (32 to +122°F)
Storage	
With Batteries	-40 to 60°C (-40 to 140°F)
Without Batteries	-40 to 75°C (-40 to 167°F)
Humidity	
0 to 50°C (32 to 122°F)	80% non-condensing
0 to 35°C (32 to 95°F)	90% non-condensing
Shock and Vibration	Meets requirements of MIL Standard 810

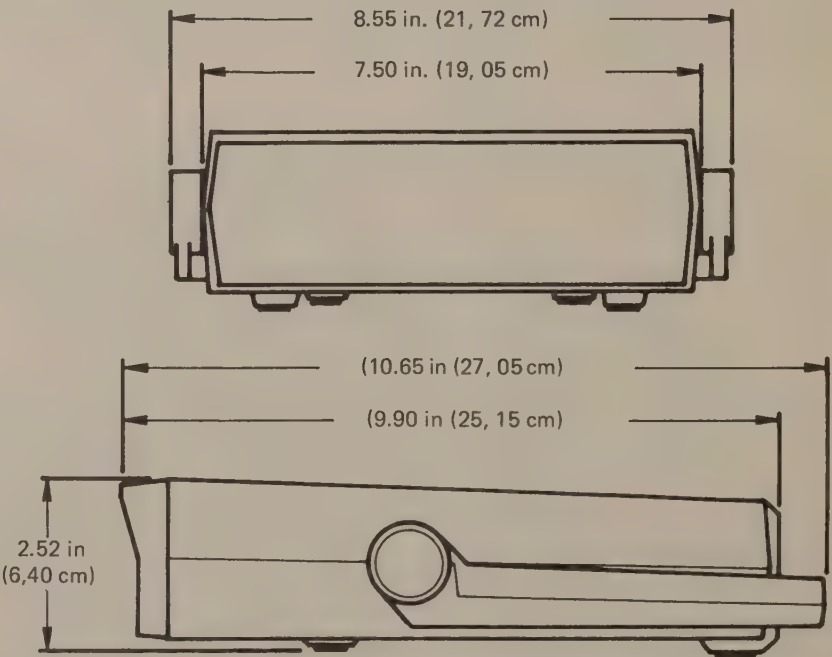


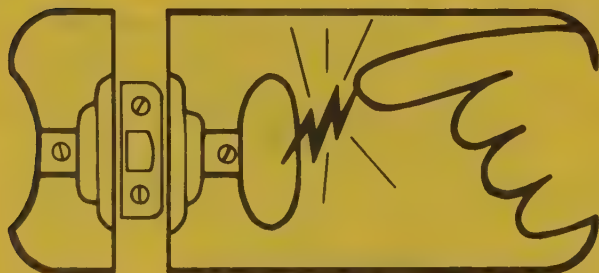
Figure 1-1. OUTLINE DRAWING



static awareness



A Message From
John Fluke Mfg. Co., Inc.



Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⚡"

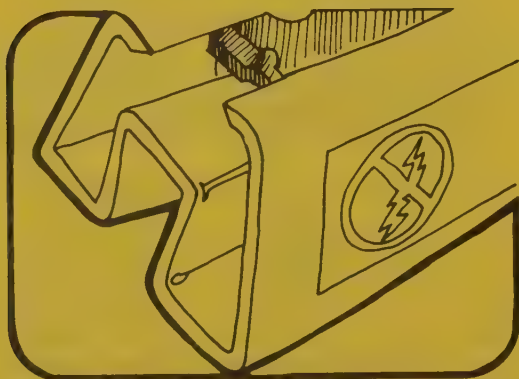
The following practices should be followed to minimize damage to S.S. devices.



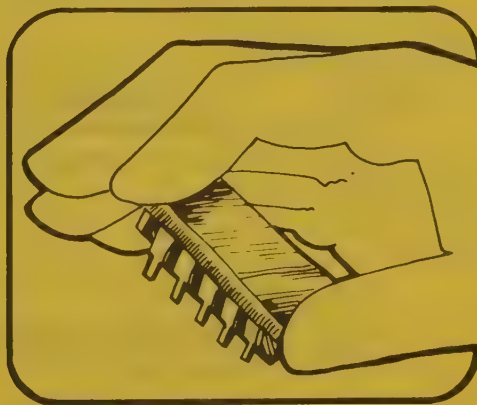
1. MINIMIZE HANDLING



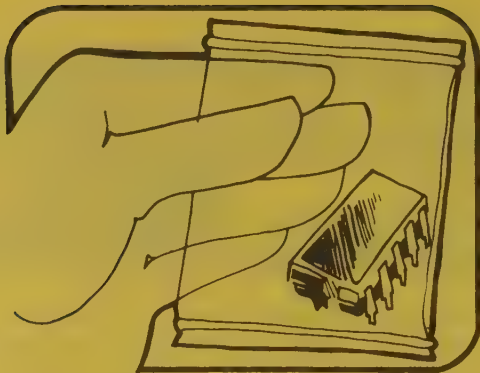
3. DISCHARGE PERSONAL STATIC
BEFORE HANDLING DEVICES



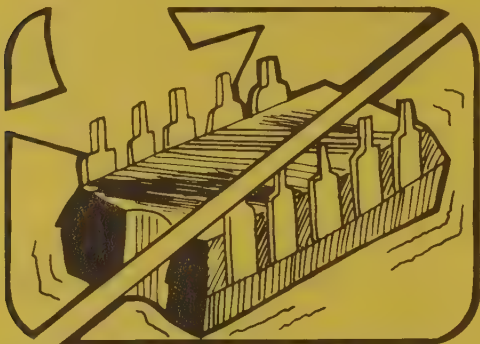
2. KEEP PARTS IN ORIGINAL CONTAINERS
UNTIL READY FOR USE.



4. HANDLE S.S. DEVICES BY THE BODY



5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT

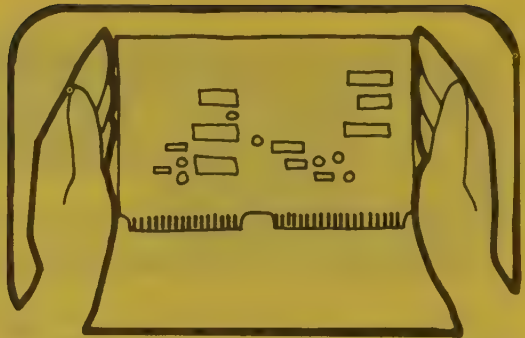


6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE

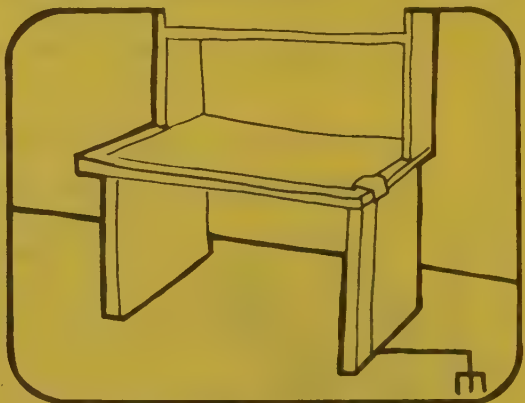


7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

PORTIONS REPRINTED
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AND GENERAL DYNAMICS, POMONA DIV.



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION
10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.
11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
680892	5" x 8" Bag
680934	8" x 10" Bag
680942	8" x 12" Bag
680983	12" x 16" Bag
681023	18" x 18" Bag

Pink Poly Sheet	Wrist Strap
30" x 60" x 60 Mil	P/N TL6-60
P/N RC-AS-1200	\$7.00
\$20.00	

Section 2

Operating Instructions

WARNING!

Due to the possible presence of lethal voltages, the procedures in paragraphs 2-17 and 2-21 should be performed by qualified personnel only.

2-1. INTRODUCTION

2-2. This section of the manual contains information about installation and operation of the Model 2175A Digital Thermometer. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest Fluke Technical Service Center, or the John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, WA 98043, Tel. (206) 774-2211. A list of Technical Service Centers is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 2175A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included in the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 2175A is factory wired to operate from one of three ac line voltages. These are: 100V ac, 50 to 440 Hz; 115V ac, 50 to 440 Hz; and 230V ac, 50 to 440 Hz. Before connecting the 2175A to the ac line, check to ensure that the instrument is wired to accommodate the local line voltage. A decal on the underside of the unit defines the particular line voltage required to operate the instrument.

2-8. The rear panel ac input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the appropriate line voltage. The offset prong on this connector is connected to the 2175A power supply, and should be connected through the power cord to a high quality earth ground.

2-9. RACK INSTALLATION

2-10. The 2175A is designed for field and bench-top use or for installation in a standard 19-inch equipment rack using an accessory rack-mounting kit. Kits are available for left, right, center or side-by-side mounting of the 2175A. Information regarding installation of the rack mounting accessories is given in Section 6 of this manual, Option and Accessory Information.

2-11. OPERATING FEATURES

2-12. The location of all 2175A controls, indicators and connectors are shown in Figure 2-1, and described in Table 2-1.

2-13. OPERATING NOTES

2-14. The following paragraphs describe various conditions which should be considered before operating the 2175A.

2-15. Option Information

2-16. Supplementary operating instructions are necessary when operating a 2175A which is equipped with one of the available options. Detailed information regarding the operation of each available option is given in Section 6 of this manual, Option and Accessory Information.

2-17. Fuse Replacement

WARNING

Disconnect the unit from line power before attempting to replace the fuse.

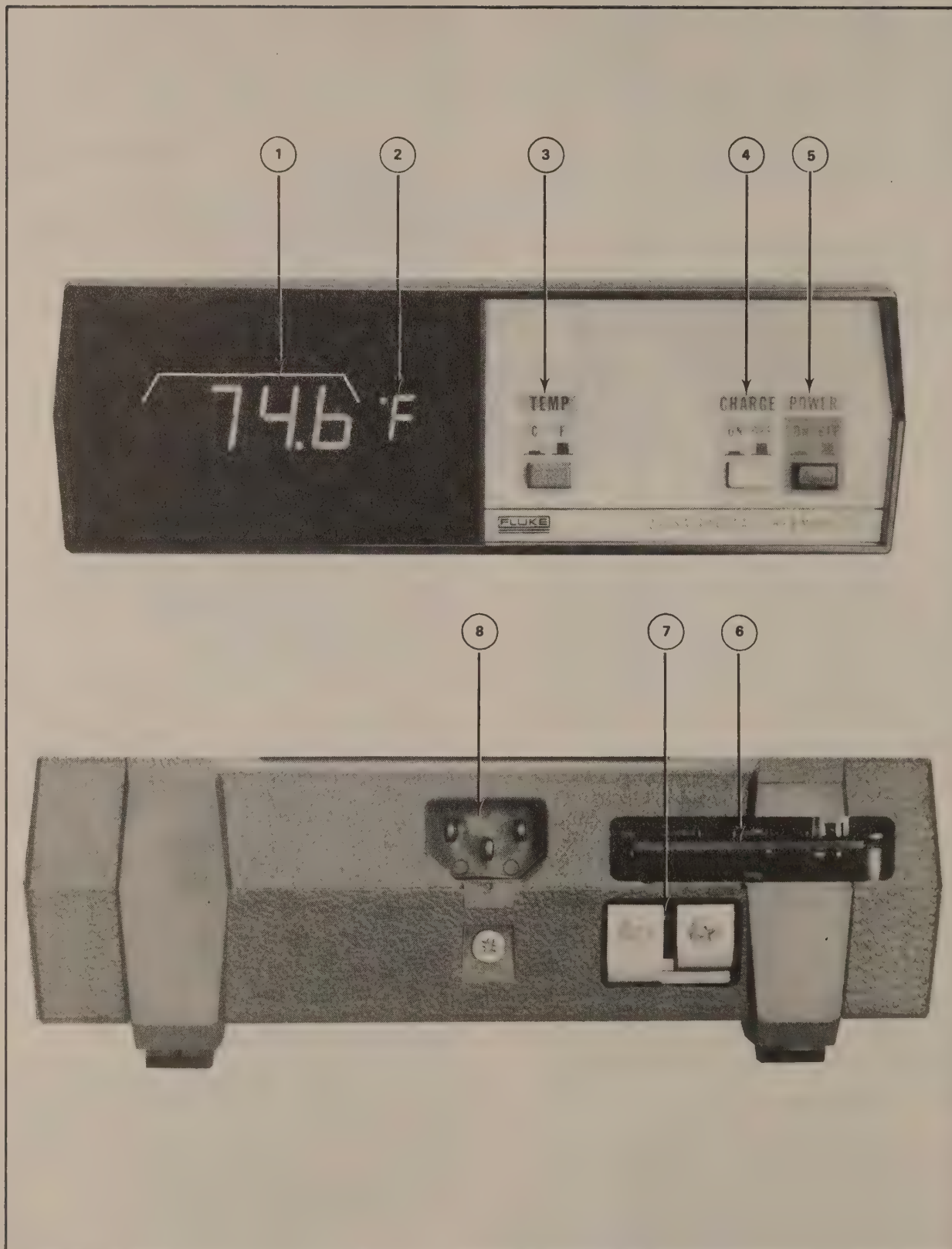


Figure 2-1. CONTROLS, INDICATORS AND CONNECTORS

Table 2-1. 2175A CONTROLS, INDICATORS AND CONNECTORS

REF. NO.	NAME	FUNCTION
1	Digital Display	Displays a four digit readout of the measured input temperature. Leading-zero suppression and a fixed decimal point are also included. A minus sign is displayed for negative temperature measurements. The absence of a polarity sign indicates a positive temperature measurement.
2	Temperature Scale Indicator	Displays the temperature scale represented by the digital display data; °C or °F.
3	TEMP Select Switch	Selects the temperature scale for the digital display. When the switch is depressed (IN), the °C scale is selected. The °F scale is selected when the switch is released (OUT).
4	CHARGE Switch	Selects the charge rate when the Battery Option (—01) is installed. When the switch is depressed (ON) the fast charge rate is enabled and the thermometer is not operational. The unit is operational when the CHARGE switch is released (OFF), and the batteries are charged at a trickle rate.
5	POWER Switch	Switches the 2175A on or off. The unit is turned on when the switch is depressed.
6	DOU, AOU I/O Port	Provides access to the input/output connector of the Digital Output Unit (Option —02) or the Analog Output Unit (Option —04) when either option is installed.
7	Thermocouple Input Connections	Provides screw-type input terminals for connecting the thermocouple to the thermometer.
8	Input Power Connector	Provides the means of connecting the instrument through the power cord to ac line power.

2-18. The ac line-input section of the 2175A power supply is fuse protected. The fuse is located on the interior of the unit near the power transformer. To access the fuse, remove the rear-panel retaining screw located beneath the ac line connector, and pull the case from the instrument. When replacement is necessary, use a MDL (Slo-blo) 1/8A fuse.

2-19. Overload and Open Thermocouple Indication

2-20. The front panel display, in addition to providing a measurement reading, is designed to serve as an overrange or open thermocouple indicator. When the measurement range of the input thermocouple is exceeded, or when the thermocouple inputs are open circuited, the display will blink. The blinking indications does not mean that the instrument is being exposed to a damaging input condition.

2-21. Thermocouple Compatibility

2-22. The 2175A is designed to operate in conjunction with a selected type of thermocouple probe. A decal on the bottom of the unit identifies the compatible thermocouple type. When necessary, the 2175A can be modified in the

field to accommodate any one of the following thermocouple types: J, K, E or T. Use the following procedure to change thermocouple types:

- Refer to Table 1-1 in Section 1 of this manual and order the type select pcb which corresponds to the desired thermocouple type. These pcb's are low-cost items and can be purchased from any one of the John Fluke Technical Service Centers (See Section 7) or from the John Fluke Mfg. Co., Inc.
- Disconnect the 2175A from line power.
- Remove any ribbon-cable connectors that may be attached to the rear of the 2175A.
- Disconnect the power cord from the rear of the unit.
- Remove the rear-panel screw located just below the power input connector.
- Pull the 2175A front panel and pcb assembly out the front of the plastic case.

- g. Unplug and remove the currently installed type select pcb from the position shown in Figure 2-2, and install the new one in its place.

NOTE

The thermocouple type is etched on the type select pcbs. When properly installed the arrows on the pcb point toward the digital display.

- h. Place a piece of tape over the thermocouple type indications on the bottom-side decal, and mark the new thermocouple type on it.
- i. Connect the new thermocouple type probe to the thermocouple input terminals. Observe polarity shown on bottom-side decal.

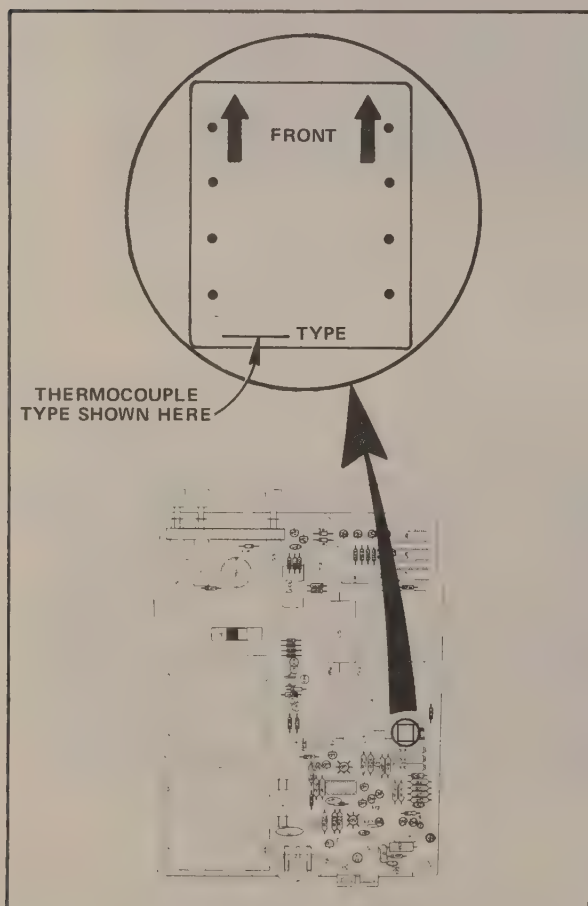


Figure 2-2. TYPE SELECT PCB, LOCATION AND INSTALLATION DETAILS

- j. Connect the unit to line power, and complete the routine calibration procedure given in Section 4 (Maintenance) of this manual.
- k. Install the unit in its case.

2-23. CHARGE Switch

2-24. The front panel CHARGE switch is operational only when the 2175A is equipped with the Battery Option (–01) and LINE/BATT switch on the interior of the unit is set to (BATT). (If the switch is not set to BATT, installed batteries will not provide power nor receive a charge.) When the charge function is enabled (BATT) and the unit is operating from line power, depressing the CHARGE switch causes the batteries to be charged at a fast rate. The thermometer operation is disabled for the duration of the fast charge period. When the CHARGE switch is out, the thermometer is operational and the batteries are charged at a trickle rate.

2-25. OPERATION

2-26. With reference to previous paragraphs in this section, use the following procedure to operate the 2175A:

- a. Refer to the bottom decal on the unit and connect a compatible thermocouple probe to the thermocouple input terminals. Observe polarity as shown on decal.
- b. Connect the unit to the appropriate line power (not necessary if the unit is equipped with a charged set of batteries) as defined on the bottom decal.
- c. Energize the unit by depressing the POWER switch.
- d. Set the CHARGE switch to the OFF position. See Section 6 for details concerning battery operation (Option –01).
- e. Set the TEMP switch to the desired temperature scale, °C or °F.
- f. Refer to Section 6 of this manual for instructions concerning the operation of the –02 and –04 Options.
- g. Expose the thermocouple probe to a temperature within its specified range (See bottom decal). The probe temperature will be displayed on the front panel.

Section 3

Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description followed by a circuit analysis of the 2175A. Simplified circuit diagrams and timing diagrams are included, as necessary, to supplement the text. Detailed schematics are given in Section 8 of this manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The Model 2175A Digital Thermometer, as shown in Figure 3-1, is a four-digit, thermocouple thermometer capable of resolving 0.2°C or 0.2°F over a temperature range of -99.8 to $+999.8^{\circ}\text{C}$ or -99.8 to 999.8°F . It features a cold-junction compensator (to eliminate the need for an ice-bath reference junction), dual-slope integration, LSI digital control logic (includes linearization programs for J, K, E and T type thermocouples), and a four-digit LED display.

3-5. In operation, the 2175A executes a continuous series of measurement cycles to update the temperature display. The measurement cycle is controlled entirely by an LSI digital IC, and includes three major subcycles; Auto-Zero period, Integrate period and Read period. Each sub-cycle controls the operation of the analog section of a dual-slope integrator which, in turn, generates a compare output to control the digital conversion performed by the LSI digital IC.

3-6. The configuration of the analog section of the 2175A, during each phase of the measurement cycle, is established by a combination of FET switches that are controlled by the LSI digital IC. The measurement cycle begins with the Auto-Zero period. During this period, the reference junction compensation voltage and the accumulated dc offset voltages present in the analog section are sampled and held by capacitors. These voltages are used later in the measurement cycle to cancel measurement errors introduced by offset voltages

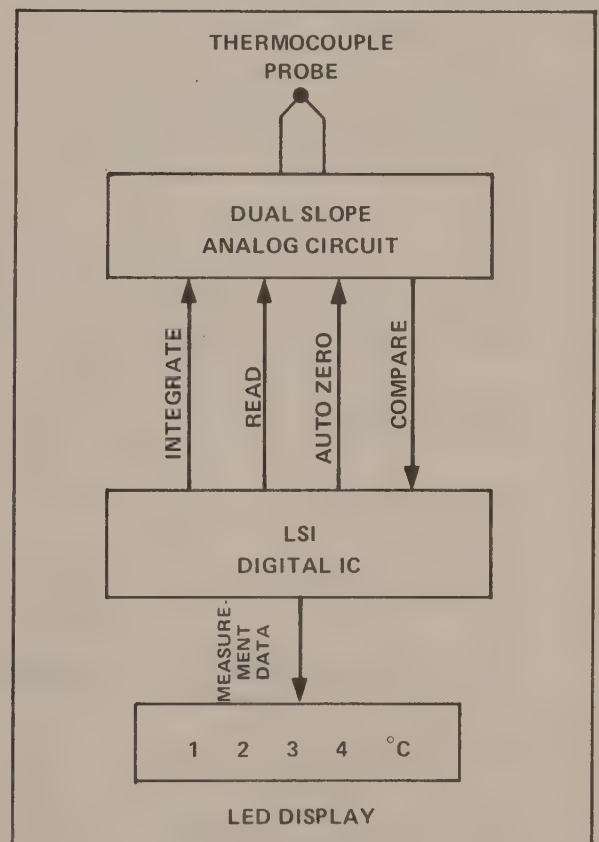


Figure 3-1. 2175A SIMPLIFIED BLOCK DIAGRAM

and reference junction voltage errors created at the input terminal connections. As a result, the final measurement is proportional to the thermocouple probe output voltage and does not include offset errors or reference junction voltage errors. During the Integrate period, the thermocouple input voltages (probe voltage and input terminal voltages) are applied to the integrator, and the algebraic sum of these volt-

Zero period, a 100 ms Integrate period, and a variable Read period. The auto-zero period is extended to 300 ms when an overload occurs. To accommodate settling times in the analog section, a 500 μ s hold signal is inserted at the beginning and at the end of the Integrate period.

3-14. Analog Section

3-15. ANALOG MEASUREMENT CIRCUIT

3-16. The analog measurement circuit is shown in simplified form in Figure 3-3. It consists of a thermocouple input circuit, a reference-junction compensator, a voltage reference, a Buffer Amplifier, an Integrator, a Comparator, and a combination of FET switches. The switches are shown in their open state and are closed by the measurement cycle commands generated by the LSI digital IC. Each switch is assigned a letter designation which corresponds to a measurement cycle command shown in Figure 3-2.

3-17. The Thermocouple Input circuit consists of an R-C filter and a pair of voltage protection diodes. The difference between the thermocouple probe voltage and the input terminal voltage is passed through the filter and appears at the arm of switch C.

3-18. The Reference-Junction Compensator consists of an isothermal block, a pair of screw type input terminals, and a transistor temperature sensor. The isothermal block maintains a known temperature differential between the input terminals and the temperature sensing transistor. Thermocouple voltages introduced by the dissimilar metals at the input terminals vary as the isothermal block adjusts to ambient temperature. Temperature changes are sensed by the forward-

biased transistor which produces a correction voltage equivalent to the thermocouple voltage created at the input terminals. Predictable characteristics of a forward-biased P-N junction allow the Reference-Junction Compensator to function over a wide temperature range. The correction voltage is matched to the thermocouple probe type by a selected Offset Resistor which is supplied on a plug-in type select pcb. The correction voltage appears at the arm of switch B1.

3-19. The voltage reference consists of a resistor divider which is supplied by an accurate 6.4V dc reference voltage. The divider is calibrated to match the thermocouple probe type by a selected resistor on the plug-in type select pcb. Two voltages are available at the divider outputs; $0.5 \times V_{ref}$ and $1.5 \times V_{ref}$. These voltages appear at the arms of switches B2 and E, respectively.

3-20. The Buffer, Integrator and Comparator amplifiers combine to perform the analog functions of the Integrate, Read and Auto-Zero periods. The Buffer is used to provide integrator inputs during all three periods. The Integrator integrates the Buffer output voltage during the Integrate and Read periods, and functions, in combination with the Comparator, as a closed-loop amplifier during the Auto-Zero period.

3-21. During the first phase of each measurement cycle, the analog section goes through an Auto-Zero period. During this time, three auto-zero switches (B1, B2 and B3) are closed by the Auto Zero command from the LSI digital IC. Two of the switches (B1 and B2) charge the V_{ref} capacitor to a level equal to the algebraic sum of the $0.5 \times V_{ref}$ output, plus the correction voltage generated by the Reference-Junc-

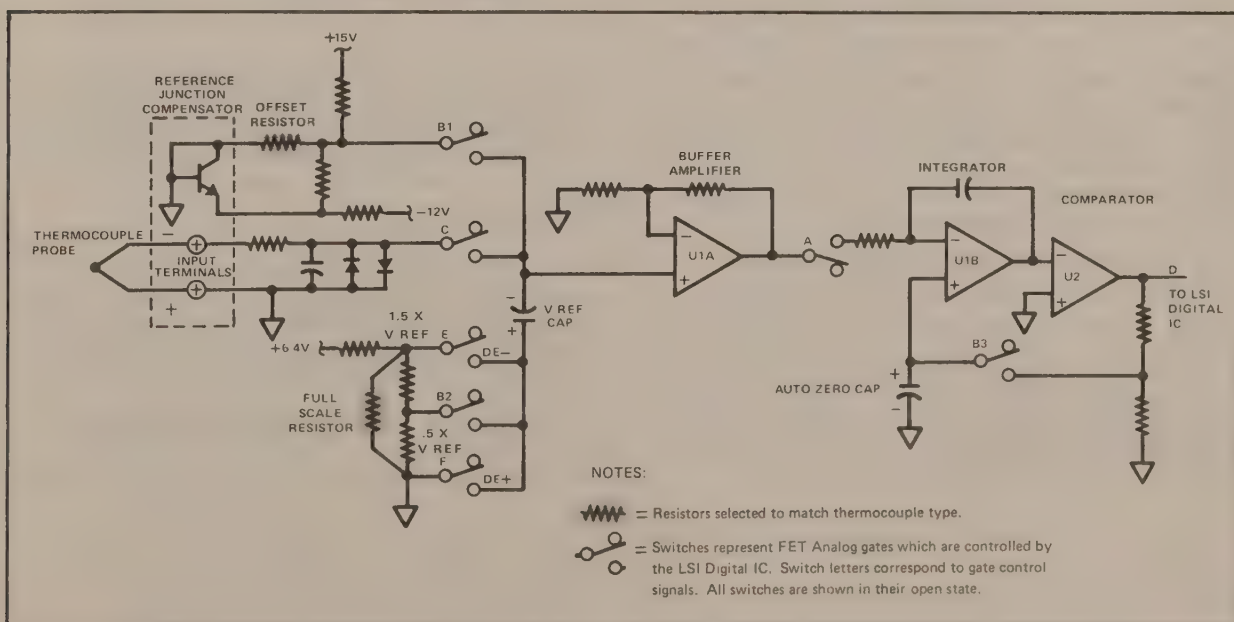


Figure 3-3. ANALOG SECTION, SIMPLIFIED CIRCUIT DIAGRAM

tion Compensator. At the same time, the correction voltage is amplified by the Buffer Amplifier and presented through switch A to the Integrator input. The third switch (B3) connects the Integrator and Comparator in a closed loop configuration and allows the Auto-Zero capacitor to charge to a value which is proportional to the Reference-Junction-Compensator correction voltage plus the offset voltages present in the Buffer, Integrator and Comparator amplifiers. At the end of the measurement cycle switches B1, B2 and B3 are opened. The V ref capacitor and the Auto-Zero capacitor retain their charge for use later in the measurement cycle.

3-22. The Integrate period starts on the leading edge of the Integrate Command from the LSI digital IC; switch A is open and switch C is closed. The thermocouple input voltage is applied through switch C to the Buffer input. After a 500 μ s settling period, switch A closes and the Buffer output voltage is applied to the Integrator input for 100 ms. As the integrator capacitor charges, the Integrator drives the Comparator output to either 0 or +5V dc to indicate the polarity of the thermocouple input voltage, positive or negative, respectively. The comparator output is sent to the LSI digital IC for use during the Read period. At the end of the Integrate period, the integrator capacitor is charged to a level and polarity that is proportional to the thermocouple probe voltage and switch C returns to its open state.

3-23. The Read period starts at the end of the Integrate period and one-of-two Read Modes is enabled depending upon the input polarity sensed by the comparator during the Integrate period. If a positive input is sensed, a DE– Read Mode is enabled. Similarly a DE+ Read Mode is enabled when a negative input is sensed.

3-24. If the DE– Read Mode is commanded, switch A is opened and E is closed. Switch E applies a $1.5 \times V_{ref}$ input to the positive side of the V ref capacitor. This voltage is algebraically added to the voltage stored in the V ref capacitor during the previous Auto-Zero period ($0.5 \times V_{ref} + \text{Reference-Junction-Compensator voltage}$). As a result, the input to the Buffer Amplifier is a positive voltage equal to V ref plus the Reference Junction-Compensator voltage.

3-25. If the DE+ Read Mode is commanded, switch A is opened and F is closed. Switch F grounds the positive side of the V ref capacitor and causes the Buffer amplifier input to be driven to the voltage stored in the V ref capacitor during the previous Auto-Zero period ($0.5 \times V_{ref} + \text{Reference-Junction-Compensator voltage}$). As a result, the input to the Buffer Amplifier is a negative voltage equal to $0.5 \times V_{ref}$ plus the Reference-Junction-Compensator voltage.

3-26. After a 500 μ s settling time, switch A closes and the Buffer output voltage is applied to the Integrator input. This causes the integrator capacitor to discharge at a linear rate determined by the reference voltage. The discharge continues until the integrator output voltage reaches zero volts, the level existing prior to the integrate period. This level is sensed by the Comparator which signals the LSI digital IC to terminate the A/D conversion of measurement data.

3-27. Offset voltages present during the Integrate and Read periods are cancelled out by offset voltages that were sampled and held during the Auto-Zero period. However, the Reference-Junction-Compensator voltage (also sampled and held during Auto Zero) is added to the integrator voltage during the Integrate period. As a result, the displayed temperature is equal to the thermocouple probe temperature.

3-28. POWER SUPPLY

3-29. The 2175A power supply consists of a power transformer, fuse, power input connector, a dc-to-dc converter, battery holders, and associated regulating and charging circuits. The function of the power supply is to provide the unit with the necessary operating voltages during both battery and line operation, and to provide a means of recharging the Ni-Cad batteries, when installed. Operating voltages include: +5, +6.8, +15 and –12V dc, and 5V ac (rms). All voltages except the +5V dc and the 5V ac are regulated.

NOTE

The 5V ac output is used to power the –02 and –04 options. Since this voltage is not generated during battery operation, the –02 and –04 options are operational only when the 2175A is operated from line power.

3-30. The dc-to-dc converter is energized by a +5V dc input which is derived from either the power transformer during line operation, or the rechargeable batteries during battery operation. Conventional regulating techniques produce +6.8, +15 and –12V dc operating voltages at the dc-to-dc converter output.

3-31. When batteries are installed in the 2175A and an internal Line/Battery switch is set to BATT, the front panel CHARGE switch is enabled. During line operation, the CHARGE switch provides selection of either fast (ON) or slow (OFF) battery charge rates. The unit is operative only during slow-charge. However, during fast-charge the numeric display is blanked and the °C temperature scale character is lit. Lamp DSI operates as a ballast in the fast charge mode.

Section 4

Maintenance

WARNING!

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual provides information about warranty, factory service, maintenance, performance testing, routine recalibration and recalibration after repair. The performance test is recommended when the instrument is received and later as a preventive maintenance tool or for testing after repair. The test verifies performance at several temperatures within the range of a given thermocouple type. Specifications are provided both for annual and for a more precise 90-day performance-testing cycle.

4-3. SERVICE INFORMATION

4-4. The instrument is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page located in the front of this manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before any work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Access Information

4-8. Use the following procedure to gain access to the interior of the instrument:

- a. Set the POWER switch to OFF and disconnect the ac power cord from the unit.

- b. Disconnect the thermocouple probe at the input terminals.
- c. Remove the phillips-head screw located in the center of the rear panel.
- d. Pull the instrument out of the front of the case.

4-9. Cleaning

- 4-10. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They will react with plastic materials used in manufacture of the instrument.

- a. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.
- b. Clean the surface of the pcb using clean dry air at low pressure (≤ 20 psi). If grease is encountered, spray with Freon T. F. Degreaser or anhydrous alcohol and remove grime with clean dry air at low pressure.

4-11. Fuse Replacement

WARNING!

DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACEMENT.

4-12. The input power fuse is located on the interior of the unit near the ac line connector. If replacement is necessary, use an MDL (Slo-blo) 1/8A fuse.

4-13. Service Tools

4-14. No special tools are required for maintenance or repair.

4-15. PERFORMANCE TEST

4-16. Table 4-1 lists the equipment required for performance testing and recalibration. If the recommended model of test equipment is not available, a substitute that meets the minimum use specifications may be used. Table 4-2 outlines the Performance Test. A Performance Checklist at the end of this section may be reproduced or removed to provide a written record of results. The Performance Test verifies instrument performance to specifications for initial acceptance or for maintenance. (Periodic recalibration requires the calibration procedure beginning in paragraph 4-27). If the thermometer fails to meet specifications, it requires recalibration or repair. Review Table 4-2, then continue.

Table 4-1. TEST EQUIPMENT REQUIREMENTS

TEST EQUIPMENT	MINIMUM USE SPECIFICATIONS	RECOMMENDED MODEL
Thermocouple Probes	Type J, K, T, E ANSI C96.1 (Select type compatible with thermometer)	Omega TJ36 Series, Grounded Sheath
Mercury, thermometer (either °C or °F)	0.02°C Resolution 0.05°F Resolution	Princo Model ASTM-56C Princo Model ASTM-56F
Dewar Flask/Cap	1-pint capacity	Thermos
DC Voltage Calibrator	Output Voltage: 0 to 10V Accuracy: 0.002% Resolution: 10 mV	Fluke Model 343A
Voltage Divider 100:1 or Kelvin-Varley Divider (Shunt output with 1 uF capacitor)	Ratio: 0.005%	Fluke A21-5 or Fluke 720A or Fluke 750A
Variable Line-Voltage Transformer	100, 115, 230V ac, as required, ±10%	General Radio VARIAC W5HM
Decade Resistor	Accuracy: 1% Ranges: 1K, 10K and 100K	General Radio 1434

NOTE

The Performance Test should be conducted at an ambient temperature of 25.0 ± 2.0° C (77.0 ± 3.6° F).

4-17. Set-up Procedure

- 4-18. The following steps prepare for performance testing:
- a. Remove the thermometer from its case.
 - b. Check the position of the line-battery switch. An instrument with no batteries should have the switch set to LINE position. An instrument containing batteries should have the switch set to the BATT position.
 - c. Locate the RJD switch on the main pcb (See Figure 4-1) and set it to the RJD position. (This defeats the reference-junction circuitry.)

Table 4-2. PERFORMANCE TEST DESCRIPTION

TEST	PERFORMANCE SPECIFICATIONS	TEST METHOD	BEGINNING TEXT PARAGRAPH
Setup			4-17
Overload and Open Input Test	The display flashes to indicate both over range input voltages and open input terminals.	An over range voltage is applied to the thermocouple input terminals, and the input terminals are open circuited.	4-19
Line Voltage Regulation	Satisfactory performance with any line voltage within ±10% of nominal; 100, 115 or 230V ac	The display is monitored during the accuracy test as the line voltage is varied.	4-21
Accuracy Test	Temperature Accuracy as stated in Table 4-3	Known input voltages are substituted for the thermocouple inputs. Cardinal-point checks ensure accuracy over the entire temperature range.	4-23
Internal Temperature Rise	< 8°C (14.4°F) above ambient	The thermocouple input terminals are shorted and the temperature of the reference junction is displayed.	4-25

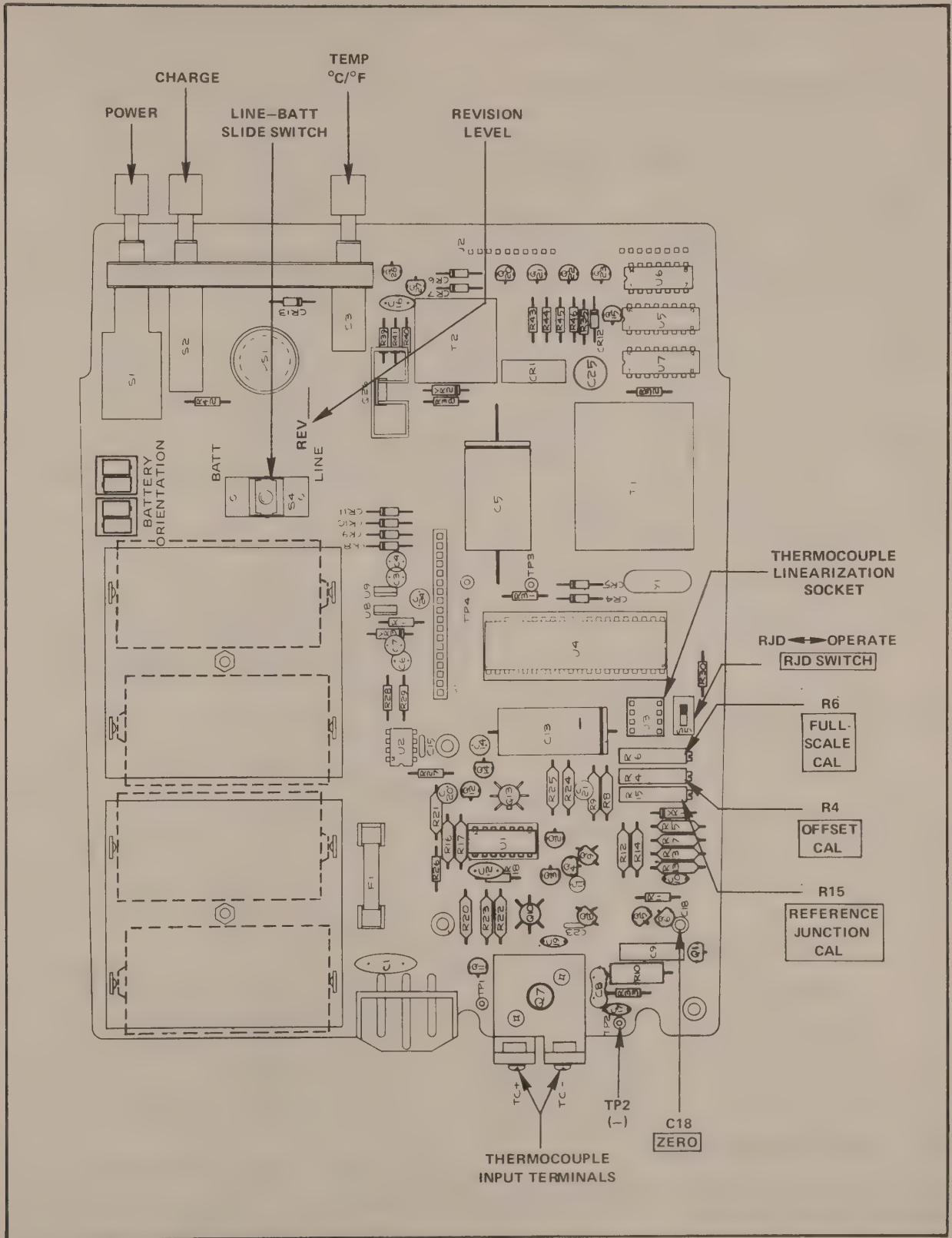


Figure 4-1. TEST POINT AND ADJUSTMENT LOCATIONS

- d. Connect a voltage divider to a dc voltage calibrator as in Figure 4-2. (See Table 4-1 for specifications.)
- e. Connect the voltage-divider output to the thermometer input terminals. Match polarity.

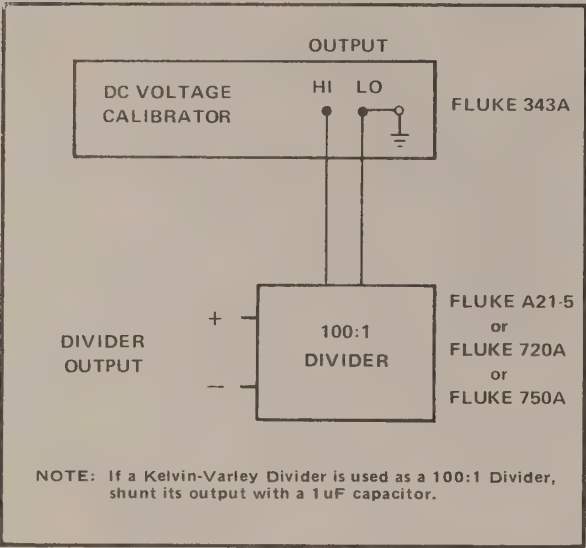


Figure 4-2. VOLTAGE DIVIDER—CALIBRATOR CONNECTION

- f. Connect a variable line-power transformer to line power and adjust the output to the nominal line voltage at which the thermometer is designed to operate; 100, 115, or 230V ac.
- g. Connect a power cord between the transformer output and the thermometer ac line connector.
- h. Set the thermometer front-panel controls as follows:
 - 1. POWER switch to ON.
 - 2. TEMP switch to °F or °C.
 - 3. CHARGE switch to OFF.
- i. Set the calibrator to zero volts output, 10 volt range, and turn it on.

4-19. Overload and Open Input

- 4-20. The following procedure tests the thermometer overload and open-circuit detectors:
- a. Set the calibrator output to 10V dc. The thermometer display should begin to flash. While the

display is lit, it should read the high end of the temperature range assigned to the compatible thermocouple type:

J	=	999.8° F	or	777.8° C
K	=	999.8° F	or	999.8° C
T	=	752.0° F	or	400.0° C
E	=	999.8° F	or	999.8° C

- b. Set the calibrator output to 0V dc.
- c. Remove the input connections at the thermometer thermocouple input terminals. The display should begin to flash and read the low end of the temperature range:

J	=	-99.8° F	or	-99.8° C
K	=	-99.8° F	or	-99.8° C
T	=	-99.8° F	or	-99.8° C
E	=	-99.8° F	or	-99.8° C

- d. This completes the Overload and Open-Input test.

4-21. Line Voltage Regulation

4-22. Line voltage regulation is tested in conjunction with the accuracy test given in the following paragraphs. As the accuracy test is executed, vary the line voltage $\pm 10\%$ with the variable line-power transformer to ensure the proper operation within the line-voltage limits.

4-23. Accuracy Test

4-24. The following procedure tests the accuracy of the thermometer.

- a. Connect the voltage-divider leads to the thermocouple input terminals. Match polarity.
- b. Refer to Table 4-3 and select the group of values that correspond to the thermocouple type used with the thermometer.
- c. Sequentially, set the calibrator to obtain each of the divider output voltages listed within the selected group, and check the thermometer display against the appropriate display limits; 90-day or 1-year. Vary the ac voltage over the specified $\pm 10\%$ operating range. Check to see that the thermometer is still reading within accuracy specifications.
- d. Remove the voltage divider from the thermometer input.
- e. Set the RJD switch to the operate position.
- f. Install the thermometer in its case.

Table 4-3. TEMPERATURE ACCURACY

TYPE	DIVIDER OUTPUT (mV dc)	°F		DIVIDER OUTPUT (mV dc)	°C	
		DISPLAY LIMITS			DISPLAY LIMITS	
		90 DAY	1 YEAR		90 DAY	1 YEAR
J	29.263	990.8 to 993.2	990.4 to 993.6	42.640	754.9 to 756.3	754.5 to 756.7
	2.288	110.8 to 113.2	110.4 to 113.6	2.288	43.7 to 45.1	43.3 to 45.5
	−1.643	−29.6 to −26.4	−30.1 to −25.9	−2.175	−45.4 to −43.4	−45.6 to −43.2
	−3.198	−89.6 to −86.4	−90.1 to −85.9	−3.686	−78.8 to −76.8	−79 to −76.6
K	22.059	990.6 to 993.4	990.2 to 993.8	40.404	976.7 to 978.9	976.4 to 979.2
	2.709	150.6 to 153.4	150.2 to 153.8	0.884	21.1 to 23.3	20.8 to 23.6
	−1.691	−50 to −46	−50.6 to −45.4	−1.691	−45.6 to −43.2	−45.9 to −42.9
	−2.475	−90 to −86	−90.6 to −85.4	−2.848	−79 to −76.6	−79.3 to −76.3
T	20.188	731 to 733	730.5 to 733.5	19.497	377.2 to 378.4	376.9 to 378.7
	0.879	71 to 73	70.5 to 73.5	0.879	21.6 to 22.8	21.3 to 23.1
	−1.240	−29.7 to −26.3	−30.9 to −25.1	−2.009	−56.6 to −54.6	−57.2 to −54
	−2.370	−89.7 to −86.3	−90.9 to −85.1	−2.720	−78.8 to −76.8	−79.4 to −76.2
E	39.694	990.7 to 993.3	990.2 to 993.8	74.694	976.8 to 978.8	976.4 to 979.2
	2.694	110.7 to 113.3	110.2 to 113.8	2.694	43.4 to 45.5	43 to 45.8
	−1.897	−29.7 to −26.3	−31 to −25	−3.080	−56.6 to −54.6	−57.3 to −53.9
	−3.641	−89.7 to −86.3	−91 to −85	−4.196	−78.8 to −76.8	−79.5 to −76.1

- g. Connect a thermocouple of the appropriate type to the thermocouple input terminals. Match polarity. J, K, T and E thermocouples have a red wire for the negative lead.
- h. Place the thermocouple in a room-temperature lag bath. (See Figure 4-3 for an illustration of lag-bath

construction. Two holes should be drilled in the thermos lid to provide a snug fit for the mercury thermometer and thermocouple probe.)

- i. Refer to Table 4-4. Determine if the thermometer display is within the specified range of the lag-bath temperature reading.

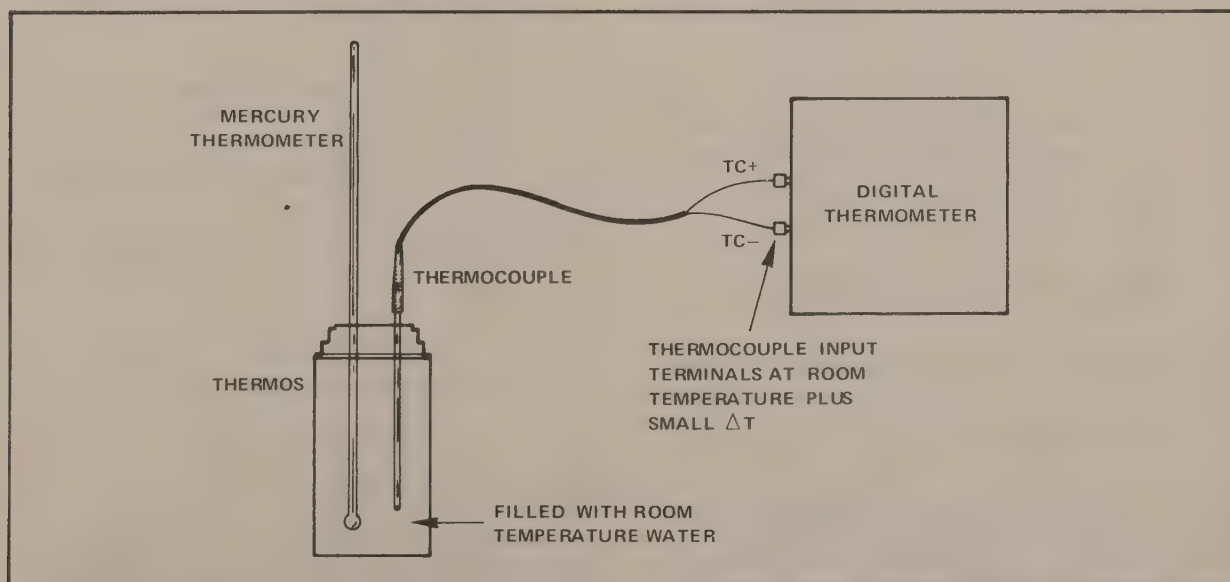


Figure 4-3. ROOM TEMPERATURE LAG BATH

NOTE

Allow sufficient time for the mercury thermometer to come to a stable lag-bath temperature reading.

Table 4-4. REFERENCE-JUNCTION ACCURACY LIMITS

TYPE THERMOCOUPLE	°F	°C
J	±1.5°	±1.5°
K	±2.0°	±1.5°
T	±1.5°	±1.5°
E	±1.5°	±1.5°
The thermometer should read within the above limits for either the 90-day or 1-year check.		

- j. This completes the accuracy test portion of the Performance Test.

4-25. Internal Temperature Rise

4-26. The following procedure measures the thermometer's internal temperature as sensed by the reference junction:

- a. Connect a copper wire between the thermocouple input terminals (in place of the thermocouple leads used in the preceding test).

NOTE

This procedure assumes that the thermometer has been energized for at least 30 minutes.

- b. Monitor the ambient temperature (room temperature) using a mercury thermometer near the back of the digital thermometer.
- c. The digital thermometer will display the temperature of the internal reference junction. This temperature should not exceed the ambient temperature by more than 8.0° C (14.4° F).
- d. Remove the short from the thermocouple input terminals.
- e. This completes the test for internal temperature rise.

4-27. CALIBRATION

4-28. The thermometer should be calibrated every year or every 90 days, depending on the desired accuracy. Calibration should be performed also after the thermometer has been repaired or after the thermocouple linearizer (type-select) pcb has been changed.

4-29. Calibration of either the °F or °C scale, ensures the accuracy of both scales. Either scale can be verified after calibration by executing the accuracy portion of the Performance Test.

4-30. Observe all notes and precautions to ensure accuracy of calibration and to avoid damage to the digital thermometer. Observe also that reference-junction adjustment (Paragraph 4-39) is not required for routine or periodic calibration.

4-31. Calibration Procedure**4-32. SET-UP FOR CALIBRATION**

- a. Complete the equipment connections shown in Figure 4-2, by doing the following:
1. Connect the 100:1 divider specified in Table 4-1.
 2. Apply power to the calibrator and turn it on. Allow sufficient warm-up time to assure calibration-output-voltage accuracy.
- b. Remove the thermometer from its case. See paragraph 4-7.
- c. Check the position of the battery-line switch. An instrument with no batteries should have the switch set to the LINE position. An instrument with batteries installed should have the switch set to the BATT position.
- d. Locate the RJD switch on the main pcb. Set it to the RJD position. (This defeats the reference-junction circuitry.)
- e. Connect a short length of copper wire between the thermocouple input terminals.
- f. Connect the digital thermometer and calibrator to the appropriate line voltage(s).
- g. Set the thermometer front panel controls as follows:
1. POWER switch to ON.
 2. TEMP switch to °F or °C.
 3. CHARGE switch to OFF.

4-33. ZERO ADJUSTMENT

- a. Adjust C18 to obtain a steady or flashing 0.0 or -0.0 for the Celsius scale, or to obtain a steady 32.0 for the Fahrenheit scale.

4-34. FULL SCALE ADJUSTMENT

- a. Determine the thermocouple compatible with the thermometer. The decal on the bottom of the thermometer case or the markings on the plug-in linearizer (type-select) pcb indicate the thermocouple type. (See Figure 4-1.)
- b. Remove the short and connect the 100:1 divider output to the thermocouple input terminals. Match polarity.
- c. Refer to Table 4-5 and set the calibrator output to obtain the voltage divider output specified for the compatible thermocouple type, for the degree scale being used.

Table 4-5. FULL SCALE CALIBRATION

PROBE TYPE	°F		°C	
	DIVIDER OUTPUT (mV dc)	DISPLAY READING	DIVIDER OUTPUT (mV dc)	DISPLAY READING
J	+29.263	992.0°F	42.640	755.6°C
K	+22.059	992.0°F	40.404	977.8°C
T	+20.188	732.0°F	19.497	377.8°C
E	+39.694	992.0°F	74.694	977.8°C

- d. Adjust the FULL-SCALE CAL potentiometer, R6 (Figure 4-1), to obtain the temperature display specified in Table 4-5.

4-35. OFFSET ADJUSTMENT

- a. Set the RJD switch to the operate position.
- b. Remove the divider leads from the thermocouple input terminals.
- c. Short the thermocouple input terminals with a small piece of copper wire.
- d. Remove the 100:1 divider from the calibrator output.
- e. Set the calibrator to the 10V dc range.
- f. Adjust the calibrator output to .5785V dc.

CAUTION!

Be sure the voltage output of the calibrator is .5785V dc before proceeding to the next step. Improper voltage could damage the digital thermometer. Do not use the divider to obtain .5785V dc because the output impedance will create an error.

- g. Connect the positive lead from the calibrator to TC+, the positive thermocouple input terminal.
- h. Connect the negative lead from the calibrator to Test Point 2. (TP2(-) in Figure 4-1).
- i. Adjust the OFFSET CAL potentiometer, R4, for a temperature display of 25.0° C (77.0° F).
- j. Remove the calibrator output from the plus input terminal and TP2(-).
- k. Remove the short at the thermocouple input terminals.
- l. If the thermometer is being calibrated on a routine calibration cycle, or because of thermocouple type-change, this completes calibration. Reassemble the thermometer.

- m. If the thermometer is being recalibrated because of repair or if reference-junction adjustment is desired, proceed with paragraph 4-39.

4-36. REFERENCE-JUNCTION ADJUSTMENT

- a. Connect a compatible thermocouple probe to the input terminals. Match polarity. J, K, T and E thermocouples have a red wire for the negative lead.
- b. Place the thermocouple in a room-temperature lag bath. (See Figure 4-3 for an illustration of lag-bath construction.)
- c. Use an accurate mercury thermometer to monitor the temperature of the lag-bath. (See Table 4-1.)
- d. Adjust the REFERENCE-JUNCTION CAL potentiometer, R15, to obtain a display that agrees with the lag-bath temperature.
- e. Remove the thermocouple and reassemble the digital thermometer.

4-37. REFERENCE-JUNCTION BIAS-RESISTOR SELECTION

- 4-38. If the reference-junction transistor Q7 is replaced, then the reference-junction bias resistor R14 must also be replaced. This is a selected resistor which must be matched to Q7. To select the resistor:

- a. Complete the calibration paragraphs 4-32 through 4-35.
- b. Connect a compatible thermocouple probe to the input terminals. Match polarity. J, K, T and E

thermocouples have a red wire for the negative lead.

- c. Center the reference-junction pot R15.
- d. Connect a decade resistance box that has ranges including 1K, 10K and 100K, in place of the reference-junction bias resistor R14. (See Table 4-1).
- e. Place the thermocouple in a room-temperature lag bath. (See Figure 4-3 for an illustration of lag-bath construction.)
- f. Use an accurate mercury thermometer to monitor the temperature of the lag bath. (See Table 4-1.)
- g. Adjust the decade resistance box for the value from Table 4-6 that causes the thermometer to read closest to lag-bath temperature. This will be the value of the reference-junction bias resistor R14.
- h. Disconnect the decade box and install the selected R14.
- i. Adjust the reference junction potentiometer so that the thermometer reading matches the lag-bath temperature.
- j. Remove the thermocouple and reassemble the digital thermometer.
- k. This completes the selection of R14. This also completes the calibration of the reference junction.

Table 4-6. BIAS RESISTOR VALUES

VALUE	JOHN FLUKE PART NUMBER	VALUE	JOHN FLUKE PART NUMBER
49.9K	268821	90.9K	223537
52.3K	237248	100K	248807
54.9K	271353	110K	234708
57.6K	289116	124K	288407
60.4K	291419	140K	289439
63.4K	235382	162K	375998
68.1K	236828	191K	375923
73.2K	237222	237K	288373
78.7K	289058	309K	235283
84.5K	229492	562K	235358

4-39. CALIBRATION TECHNIQUES

4-40. Calibration of the reference junction (R15) can be performed using any type of thermocouple. Once the reference junction has been calibrated for one type of thermocouple, it will be in calibration for use with any other thermocouple type. Therefore, a calibration facility that maintains several digital thermometers which are configured for different thermocouple types, requires only one thermocouple probe and its corresponding linearizer (type-select) pcb in order to calibrate the reference junction of all of the instruments. A K-type thermocouple and linearizer pcb are recommended. The following procedure illustrates:

- a. Calibrate the repaired thermometer with the K-type thermocouple and K-type linearizer pcb installed. Follow paragraphs 4-32 through 4-36. This calibrates the reference junction.
- b. Change the thermometer to another type of thermocouple by changing the linearizer pcb and repeating paragraphs 4-32 through paragraph 4-35 only. These paragraphs do not require the actual thermocouple probe, but accomplish full-scale calibration for the non-K-type probe without disturbing the reference-junction calibration just set in a. above.

4-41. Thermocouple Accuracy Relating to the Reference-Junction Calibration Technique

4-42. The thermocouples specified in the list of calibration equipment meet specifications of ANSI Standard C96.1. The specifications for these probes can be as much as 4°F absolute error at or near room temperature. The first conclusion is that those probes could produce a calibration error of $\pm 4^{\circ}\text{F}$ when used for calibrating the reference junction. This is an erroneous conclusion. Figure 4-3 illustrates the set-up for calibration. Figure 4-4A illustrates the reference-junction compensation circuitry and Figure 4-4B illustrates the equivalent thermocouple circuit formed by the connection of the thermocouple to the input of the instrument. Note the in Figure 4-4B, the two thermocouple junctions formed at the input of the instrument (plus thermocouple wire (+TC) to the plus input terminal and the minus thermocouple wire (-TC) to the minus input terminal) can be represented as a single junction of +TC to -TC whose temperature is that of the input terminals of the instrument. The reference-junction circuitry senses the terminal temperature and generates a voltage that is equal to the voltage generated by the equivalent thermocouple formed at the input terminals referenced to ice point (See Figure 4-4A). For example, suppose the input terminals of the instrument and the attached probe are at the same temperature of 25°C . Since the thermocouple output voltage is proportional to the temperature between the two junctions, the

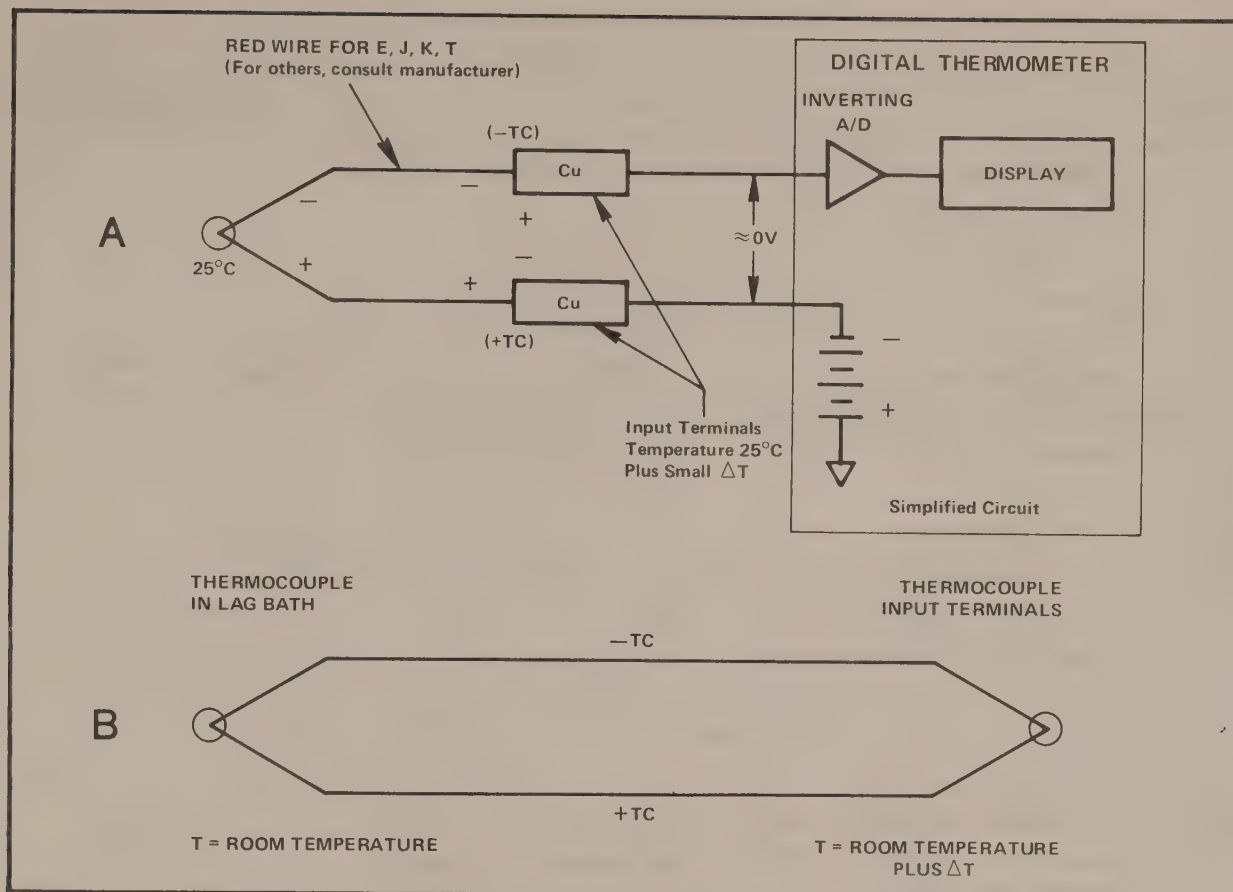


Figure 4-4. REFERENCE-JUNCTION COMPENSATION CIRCUITRY

output is zero volts. The reference-junction circuitry supplies a compensating voltage to the instrument such that the instrument will read 25°C. When calibrating the reference junction using the lag-bath technique, the reference junction is adjusted so that the instrument reads the lag-bath temperature. In using the lag-bath technique, there is only a small temperature difference, ΔT , between the thermocouple junction in the probe and the equivalent thermocouple junction formed at the input terminals of the instrument. The voltage output across the thermocouple circuit is proportional to the temperature difference, ΔT , between the two junctions. Hence, since ΔT is small, there is a small input voltage applied to the input of the instrument. This small input voltage will represent ΔT accurately to within less than .1°F. Therefore, when the reference junction is calibrated so that the instrument reads lag-bath temperature, the error introduced by the thermocouple will be less than .1°F.

4-43. Over-all Accuracy

4-44. The instrument will read very accurately around room temperature (See paragraph 4-41) but as the mea-

sured temperature increases or decreases from room temperature, the amount of thermocouple output deviation from NBS Standard 125, becomes the limiting factor in the accuracy of the instrument. If the thermocouple is in error by +4°F, at 900°F the display will be +4°F higher than if the thermocouple conformed perfectly to NBS Standard 125. Error specifications for the instrument do not include thermocouple probe inaccuracies. Those errors must be added to the instrument error in order to obtain an over-all accuracy figure.

4-45. TROUBLESHOOTING

4-46. A troubleshooting guide for the thermometer is given in Table 4-7. The guide is a simplified decision table and is recommended for use in isolating a problem to a functional circuit group. Details necessary to troubleshoot a fault in a functional circuit group can be derived from Section 3 Theory of Operation and Section 8 Schematic Diagrams.

Table 4-7. TROUBLESHOOTING GUIDE

STEP	INSTRUCTION	IF YES GO TO	IF NO GO TO	GO TO
1	Energize the unit and connect a short across the thermocouple input terminals.			2
2	Does the display light?	16	3	
3	Is the power fuse blown?	4	5	
4	Replace fuse.			2
5	Are all power supply voltages present; +5, +6.8, +15 and -12V dc?	7	22	
6	Repair power supply.			2
7	Are Strobe Out pulses present at pins 9, 10, 11 and 12 of U4? (Use logic common as reference.)	10	8	
8	Is crystal operating?	10	9	
9	Replace crystal.			2
10	Are display drivers functioning?	13	11	
11	Is output data present at pins 4,5,6 and 7 of U4?	12	13	
12	Replace display drivers as necessary.			2
13	Are $\overline{A2}$, AZ, INT, DE+ or DE-, and CM present at U4?	14	15	
14	Display PCB defective. Repair as necessary.			2
15	U4 is defective. Replace.			2
16	Does display read approximate ambient temperature?	21	17	
17	Refer to Section 3 or this manual and use a scope to check for the presence of the waveforms shown in Figure 3-2.			18
18	Are all waveforms correct?	20	19	
19	Perform the necessary repairs to the analog circuit.			17
20	Calibrate the thermometer.			21
21	End. Thermometer is functional.			
22	Are you using line power?	6	23	
23	Are batteries installed?	25	24	
24	Install and charge Ni-Cad battery pack or operate from line power.			1
25	Is Line-Battery Slide-Switch (S4) set to BATT? (See Battery Installation, Paragraph 6-19.)	26	27	
26	Recharge or replace battery pack.			1
27	Set Line-Battery slide-switch to BATT.			1

PERFORMANCE TEST CHECKLIST

Fluke Model 2175A Digital Thermometer

Serial Number _____

Tested By: _____

Date: _____

°F VERIFICATION TABLE (TEMPERATURE ACCURACY)

PROBE TYPE	NOMINAL TEMPERATURE °F	90 DAY			1 YEAR		
		MIN.	ACTUAL	MAX.	MIN.	ACTUAL	MAX.
J	992	990.8	_____	993.2	990.4	_____	993.6
	112	110.8	_____	113.2	110.4	_____	113.6
	-28	-29.6	_____	-26.4	-30.1	_____	-25.9
	-88	-89.6	_____	-86.4	-90.1	_____	-85.9
K	999	990.6	_____	993.4	990.2	_____	993.8
	152	150.6	_____	153.4	150.2	_____	153.8
	-48	-50	_____	-46	-50.6	_____	-45.4
	-88	-90	_____	-86	-90.6	_____	-85.4
T	732	731	_____	733	730.5	_____	733.5
	72	71	_____	73	70.5	_____	73.5
	-28	-29.7	_____	-26.3	-30.9	_____	-25.1
	-88	-89.7	_____	-86.3	-90.9	_____	-85.1
E	992	990.7	_____	993.3	990.2	_____	993.8
	112	110.7	_____	113.3	110.2	_____	113.8
	-28	-29.7	_____	-26.3	-31	_____	-25
	-88	-89.7	_____	-86.3	-91	_____	-85

Line Voltage Regulation _____ Passed () Failed ()

Accuracy Test _____ See Verification Tables

°F VERIFICATION TABLE (REFERENCE JUNCTION ACCURACY)

PROBE TYPE	90-Day or 1-Year	
	Deviation Error From Room-Temperature Lag Bath	
	Maximum	Actual
J	±1.5°	_____
K	±2.0°	_____
T	±1.5°	_____
E	±1.5°	_____

PERFORMANCE TEST CHECKLIST, Cont.

°C VERIFICATION TABLE (TEMPERATURE ACCURACY)

PROBE TYPE	NOMINAL TEMPERATURE °C	90 DAY			1 YEAR		
		MIN.	ACTUAL	MAX.	MIN.	ACTUAL	MAX.
J	755.6	754.9	_____	756.3	754.5	_____	756.7
	44.4	43.7	_____	45.1	43.3	_____	45.5
	-44.4	-45.4	_____	-43.4	-45.6	_____	-43.2
	-77.8	-78.8	_____	-76.8	-79	_____	-76.6
K	977.8	976.7	_____	978.9	976.4	_____	979.2
	22.2	21.1	_____	23.3	20.8	_____	23.6
	-44.4	-45.6	_____	-43.2	-45.9	_____	-42.9
	-77.8	-79	_____	-76.6	-79.3	_____	-76.3
T	377.8	377.2	_____	378.4	376.9	_____	378.7
	22.2	21.6	_____	22.8	21.3	_____	23.1
	-55.6	-56.6	_____	-54.6	-57.2	_____	-54
	-77.8	-78.8	_____	-76.8	-79.4	_____	-76.2
E	977.8	976.8	_____	978.8	976.4	_____	979.2
	44.4	43.4	_____	45.5	43	_____	45.8
	-55.6	-56.6	_____	-54.6	-57.3	_____	-53.9
	-77.8	-78.8	_____	-76.8	-79.5	_____	-76.1

Overload
Overrange Passed () Failed ()
Open Circuit Passed () Failed ()
Internal Temperature Rise <8.0°C (14.4°F) above ambient

°C VERIFICATION TABLE (REFERENCE JUNCTION ACCURACY)

PROBE TYPE	90-Day or 1-Year	
	Deviation Error From Room-Temperature Lag Bath	
	Maximum	Actual
J	±1.5°	
K	±1.5°	
T	±1.5°	
E	±1.5°	

Section 5

Lists of Replaceable Parts

REFERENCE DESIGNATOR	ASSEMBLY NAME/NUMBER	PART NO.	PAGE
A1	Digital Thermometer, Final Assembly (2175A)	_____	5-3
	Thermometer Assembly		
	100V (2175A-4001T-2)	434886	5-4
	115V (2175A-4001T)	425850	5-4
	230V (2175A-4001T)	425850	5-4
A1A1	Thermometer PCB Assembly (2175A-4001)	421214	5-5
A2	Display PCB Assembly (2165A-4003)	443515	5-9
A3	Type Select PCB Assembly	_____	5-10

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

- a. Reference Designation or Item Number.
- b. Description of each part.
- c. Fluke Stock Number.
- d. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)
- e. Manufacturer's part Number or Type.
- f. Total Quantity per assembly or component.
- g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.
- h. Use Code is provided to identify certain parts that have been added, deleted or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

- a. Quantity
- b. FLUKE Stock Number
- c. Description
- d. Reference Designation or Item Number
- e. Printed Circuit Board Part Number
- f. Instrument model and Serial number

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY
A	0123 to 50000
B	50000 and on.
C	Revision K and previous (Approx. Serial below 630,000)
D	Revision L and later (Approx. Serial 630,000 and up)
Revision Level inked on Thermometer PCB near S4 (See Figure 8-1).	



Indicates MOS device which may be damaged by static discharge.

FINAL ASSEMBLY 2175A

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	DIGITAL THERMOMETER FINAL ASSEMBLY, 2175A						
A1	Thermometer Assembly				1		
	100V ac (2175A-4001T-2)	434886	89536	434886			
	115V ac (2175A-4001T)	425850	89536	425850			
	230V ac (2175A-4001T)	425850	89536	425850			
A2	Display PCB Assembly (2165A-4003)	443515	89536	443515	1		
A3	Type Select PCB Assembly				1		
	One-of-four possible type select pcb assemblies is supplied with the unit.						
	J Type Select PCB Assembly (2160A-4016)	415653	89536	415653			
	K Type Select PCB Assembly (2160A-4017)	415661	89536	415661			
	T Type Select PCB Assembly (2160A-4018)	415927	89536	415927			
	E Type Select PCB Assembly (2160A-4019)	415935	89536	415935			
1	Adhesive	436766	89536	436766	1		
2	Case, molded plastic	427997	89536	427997	1		
3	Cord, ac line				1	1	
	100 or 115V ac	343723	89536	343723			
	230V ac	343780	89536	343780			
4	Decal, case bottom	419127	89536	419127	1		
5	Decal, front panel	419119	89536	419119	1		
6	Decal, handle	347401	89536	347401			
7	Feet, rubber	338632	89536	338632	2		
8	Handle, molded plastic	330092	89536	330092	1		
9	Lens, plastic	419085	89536	419085	1		
10	Panel, front	417485	89536	417485	1		
11	Retainer, neoprene	352484	89536	382484	2		
12	Shield	438440	89536	438440	1		
13	Washer, handle	340505	89536	340505	2		

A1 THERMOMETER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	THERMOMETER ASSEMBLY				REF		
	100V ac (2175A-4001T-2)	434886	89536	434886			
	115V ac (2175A-4001T)	425850	89536	425850			
	230V ac (2175A-4001T)	425850	89536	425850			
A1 A1	Thermometer PCB Assembly (2175A-4001)	421214	89536	421214	1		
T1	Transformer, power				1		
	100V ac (2165A-6550)	437640	89536	437640			
	115V ac (2165A-6510)	437632	89536	437632			
	230V ac (2165A-6510)	437632	89536	437632			
U4	IC, LSI digital, P-MOS 	403527	70203	C-101-86	1	1	

A1A1 THERMOMETER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1A1	THERMOMETER PCB ASSEMBLY (2175A-4001) Figure 8-1	421214	89536	421214	REF		
C1	Cap, cer, .01 uF $\pm 20\%$, 3kV	266320	56289	41C301A2	1		
C3,C4	Cap, Ta, 6.8 uF $\pm 20\%$, 35V	363713	56289	196D685X0035 KA1	2		
C5	Cap, elect, 4000 uF $\pm 100/-10\%$, 10V	330761	25088	B41010-4700/10	1	1	
C6,C7, C14, C20, C21, C24	Cap, Ta, 10 uF $\pm 20\%$, 20V	330662	56289	196D106X0020 JA1	6		
C8	Cap, mica, 100 pF $\pm 1\%$, 500V	226126	71234	DM15F100F	1		
C9	Cap, mylar, 0.47 uF $\pm 10\%$, 100V	369124	73445	C280MA/HA47 OK	1		
C10	Cap, disc, 100 pF $\pm 10\%$, 1kV	105593	71590	DD101	1		
C11	Cap, Ta, 2.2 uF $\pm 10\%$, 15V	364216	56289	196D222X9015 HA1	1		
C12	Cap, cer, .025 uF $\pm 20\%$, 100V	168435	56289	C023B101H253 M	1		
C13	Cap, polypro, 0.47 uF $\pm 10\%$, 50V	363085	89536	363085	1		
C15	Cap, cer, 2700 pF $\pm 20\%$, 100V	362889	72982	8121-A100-W5R 272M	1		
C16	Cap, cer, .0012 uF $\pm 10\%$, 500V	106732	71590	CF122	1		
C17, C19	Cap, cer, 1000pF $\pm 10\%$, 500V	357806	56289	C106B102G102 K	2		
C18	Cap, var, .25 - 1.5 pF, 2kV	218206	72982	530-000	1	1	
C23	Cap, cer, 1 pF, ± 0.25 pF, 100V	436477	72982	8101-A100-COG- 109G	1		
CR1	Diode, bridge rectifier	392910	89536	392910	1	1	
CR4 thru CR11	Diode, Si, 150 mA, 75V	203323	07910	1N4448	8	2	

A1A1 THERMOMETER PCB ASSEMBLY (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR12, CR13	Diode, Si, Rectifier	343491	04713	1N4002	2	1	
DS1	Lamp	352237	00779	85863-3	1	1	
F1	Fuse, slo-blo, 1/8A	166488	71400	MDL1-8	1	5	
J1	Connector, female, 18-pin	435024	00779	583773-8	1		
Q1 thru Q6,Q8, Q9, Q12, Q14	Xstr, J-FET, N-channel	343830	89536	343830	9	2	
Q7	Xstr, Si, NPN	329698	07263	2N2484	1	1	
Q10	Xstr, FET, dual N-channel	439703	89536	439703	1	1	
Q11, Q15	Xstr, Si, NPN	218396	04713	2N3904	1	1	
Q13	Xstr, FET, dual N-channel	379321	89536	379321	1	1	
Q20 thru Q23	Xstr, Si, NPN	381798	04713	MPS-A-13	4	1	
Q26	Xstr, Si, NPN	418459	01295	T1P-31	1	1	
Q27, Q28	Xstr, Si, NPN	272237	07263	2N4946	2	1	
R1	Res, comp, 430 $\pm 5\%$, 1/2W	109058	01121	EB4315	1		
R3	Res, mf, 15.8k $\pm 1\%$, 1/8W	293688	91637	MFF1-81582F	1		
R4, R6	Res, var, 25k $\pm 20\%$, 1/2W	285213	71450	190PC253B	2	1	
R5	Res, mf, 261k $\pm 1\%$, 1/8W	257535	91637	MFF1-82613F	1		
R7	Res, mf, 187k $\pm 1\%$, 1/8W	257469	91637	MFF1-81873F	1	1	
R8	Res, mf, 2k $\pm 0.1\%$, 1/8W	340174	91637	MFF1-82001B	1		
R9	Res, mf, 1k $\pm 0.1\%$, 1/8W	340380	91637	MFF1-81001BS	1		
R10	Res, comp, 47k $\pm 5\%$, 1W	150219	01121	GB4735	1		
R11, R29	Res, comp, 1M $\pm 5\%$, 1/4W	182204	01121	CB1055	1		
R12	Res, mf, 26.7k $\pm 1\%$, 1/8W	344465	91637	MFF1-82672B	2		
					1		

A1A1 THERMOMETER PCB ASSEMBLY (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R13	Res, mf, 150k $\pm 1\%$, 1/8W	241083	91637	MFF1-81503F	1		
R15	Res, var, 50k $\pm 20\%$, 1/2W	330688	71450	190PC503B	1	1	
R16, R17	Res, mf, 14.7k $\pm 1\%$, 1/8W	226225	91637	MFF1-81472F	2		
R18	Res, comp, 470 $\pm 5\%$, 1/4W	147983	01121	CB4715	1		
R20	Res, mf, 28.7k $\pm 1\%$, 1/8W	235176	91637	MFF1-82872F	1		
R21	Res, mf, 61.9k $\pm 1\%$, 1/8W	237230	91637	MFF1-86192F	1		
R22	Res, mf, 19.1k $\pm 1\%$, 1/8W	234963	91637	MFF1-81912F	1		
R23	Res, mf, 1k $\pm 1\%$, 1/8W	168229	91637	MFF1-81001F	1		
R24, R25	Res, mf, 82.5k $\pm 1\%$, 1/8W	246223	91637	MFF1-88242F	1		
R26	Res, comp, 680k $\pm 5\%$, 1/4W	188433	01121	CB6845	1		
R27	Res, comp, 100 $\pm 5\%$, 1/4W	147926	01121	CB1015	1		
R28, R33	Res, comp, 220k $\pm 5\%$, 1/4W	160937	01121	CB2245	2		
R30, R32	Res, comp, 20k $\pm 5\%$, 1/4W	221614	01121	CB2035	2		
R38	Res, comp, 68 $\pm 5\%$, 1/4W	147918	01121	CB6805	1		
R39	Res, comp, 2k $\pm 5\%$, 1/4W	202879	01121	CB2025	1		
R40	Res, comp, 22 $\pm 5\%$, 1/4W	147884	01121	CB2205	1		
R41	Res, comp, 330 $\pm 5\%$, 1/4W	147967	01121	CB3315	1		
R42	Res, comp, 9.1 $\pm 5\%$, 1/2W	218768	01121	EB9R105	1		
R43 thru R46	Res, comp, 27k $\pm 5\%$, 1/4W	148148	01121	CB2735	4		
S1,S2, S3	Switch Assembly, pushbutton	428490	89536	428490	1	1	
S4	Switch, slide, 4 pdt	428615	82389	53212L	1	1	C
S4	Switch, slide, 4 pdt	453985	95146	CST-042N	1	1	D
S5	Switch, slide, dpdt	423129	95146	SLS-220-1	1	1	
T2	Xfmr, inverter	436097	89536	436097	1		
U1	IC, dual opnl ampl	404087	49956	RC4739DP	1	1	
U2	IC, opnl ampl	352195	49956	RC311DN	1	1	

A1A1 THERMOMETER PCB ASSEMBLY (Cont.)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U5	IC, TTL, bcd-to-7 segment decoder/driver	340109	01295	SN7447AN	1	1	
U6	IC, res network, 60Ω	344069	89536	344069	1	1	
U7	IC, C-MOS, Hex Buffer/Inverter 	381830	02735	CD4050AE	1	1	
U8	IC, linear, voltage regulator, +15V	413187	12040	LM340T-18	1	1	
U9	IC, linear, voltage regulator, -12V	381665	04713	MC7912CP	1	1	
VR1	Diode, zener, 6.4V $\pm 2\%$	393579	04713	1N4567	1	1	
VR2	Diode, zener, 6.2V	325811	07910	1N753A	1	1	
VR3	Diode, zener, 6.8V	260695	07910	1N754A	1	1	
Y1	Crystal, 400 kHz	403352	89536	403352	1		
1	Button, dark gray	419689	89536	419689	1		
2	Button, light gray	412163	89536	412163	1		
3	Button, green	419747	89536	419747	1		
4	Connector, ac line						
	Contact, ground	338640	89536	338640	1		
	Contact, voltage	338657	89536	338657	2		
	Insulator, paper	344184	89536	344184	1		
	Insulator, plastic	338624	89536	338624	1		
5	Holder Assembly, Battery						
	Contact, battery	344200	89536	344200	8		
	Holder, battery	390450	89536	390450	4		
	Hold down, battery	347427	89536	347427	2		
6	Isothermal Block						
	Insulator	415695	89536	415695	1		
	Plate, terminal, neg	415687	89536	415687	1		
	Plate, terminal, pos	415679	89536	415679	1		
7	Socket, IC, 40-pin	418988	91506	340-AG37D	1		
8	Heat Sink	428805	89536	428805	1		

A2 DISPLAY PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	DISPLAY PCB ASSEMBLY (2165A-4003) Figure 8-3	443515	89536	443515	REF		
DS1, DS2	LED, dual 7-segment character display	419051	29083	MAN 6610	2	1	A
DS3	LED, 7-segment character display	407874	29083	MAN 4610	1	1	A
DS1 thru DS5	LED 7-segment, numeric display	418012	28480	5082-7651	5	1	B
P4	Connector, female, 16-pin	375329	00779	85863-3	1		
R1	Res, comp, 91 $\pm 5\%$, 1/4W	221887	01121	CB9105	1		

A3 TYPE SELECT PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	TYPE SELECT PCB ASSEMBLY Figure 8-5				REF		
	J Type (2160A-4016)	415653	89536	415653			
P3	Socket, IC, 8-pin	418608	00779	583640-1	1		
R1	Res, mf, 10.7k $\pm 1\%$, 1/8W	423681	91637	MFF1-81072F	1		
R2	Res, mf, 619 $\pm 0.1\%$, 1/8W	423715	91637	MFF1-86190B	1		
	K Type (2160A-4017)	415661	89536	415661			
P3	Socket, IC, 8-pin	418608	00779	583640-1	1		
R1	Res, mf, 3.74k $\pm 1\%$, 1/8W	260547	91637	MFF1-83741F	1		
R2	Res, mf, 481.4 $\pm 0.1\%$, 1/8W	423723	91637	MFF1-8481R4B	1		
	T Type (2160A-4018)	415927	89536	415927			
P3	Socket, IC, 8-pin	418608	00779	583640-1	1		
R1	Res, mf, 3.74k $\pm 1\%$, 1/8W	260547	91637	MFF1-83741F	1		
R2	Res, mf, 483.7 $\pm 0.1\%$, 1/8W	423731	91637	MFF1-8483R7B	1		
	E Type (2160A-4019)	415935	89536	415935			
P3	Socket, IC, 8-pin	418608	00779	583640-1	1		
R1	Res, mf, 53.6k $\pm 1\%$, 1/8W	291401	91637	MFF1-85362F	1		
R2	Res, mf, 732 $\pm 0.1\%$, 1/8W	423749	91637	MFF1-87320B	1		

Section 6

Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information concerning the Options and Accessories available for use with the Model 2175A Digital Thermometer. The first portion of this section provides a brief description of each option and accessory. The depth of detail is intended to give the pro-

Table 6-1. 2175A OPTIONS, ACCESSORIES AND DOCUMENTATION SOURCES

MODEL OR OPTION NO.	DESCRIPTION	DOCUMENTATION SUPPLIED	
		WITH UNIT	HERE IN
C80	Carrying Case		●
C86	Carrying Case		●
P20J	J-Type TC Probe		●
P20K	K-Type TC Probe		●
P20T	T-Type TC Probe		●
M00-100-714	Front Panel Dust Cover		●
M00-200-611	Rack Mtg. Kit, Offset	●	
M00-200-612	Rack Mtg. Kit, Center	●	
M00-200-613	Rack Mtg. Kit, side-by-side	●	
2160A-7016	J-Type Select PCB		●
2160A-7017	K-Type Select PCB		●
2160A-7019	E-Type Select PCB		●
2160A-7018	T-Type Select PCB		●
2160A-7022	Interface Cable		●
-01	Battery Pack		●
-02	Digital Output Unit	○	
-04	Analog Output Unit	○	

○ = T-punched for insertion in Section 6 of this manual.

● = Not T-punched.

spective user an adequate first acquaintance with the features and capabilities of each. Detailed information concerning specifications, operating instructions, maintenance, list of replaceable parts and schematics is supplied separately with some options and accessories, and is designed to comprise the second portion of this section. Unique page and paragraph numbering is assigned to each of the add-on descriptions to allow separation into easily identifiable subsections. The material is prepunched (T-punched) to permit insertion without disassembling the manual. Table 6-1 lists the available options and accessories and defines the manner in which each is documented.

6-3. CARRYING CASE (C80)

6-4. The Model C80 Carrying Case, Figure 6-1, is a soft vinyl plastic container designed for the storage and transport of the 2175A. The case provides the unit with adequate protection against normal handling and storage conditions. In addition to a shoulder strap, the C80 is equipped with a storage compartment for probes, power cord, and other compact accessories.



Figure 6-1. C80 CARRYING CASE

6-5. CARRYING CASE (C86)

6-6. The Model C86 Carrying Case, Figure 6-2, is a molded polyethylene container, with handle, designed for use in transporting the 2175A. This rugged case provides the unit with maximum protection against rough handling and adverse weather conditions. A separate storage compartment is provided for probes, power cord, and other compact accessories.

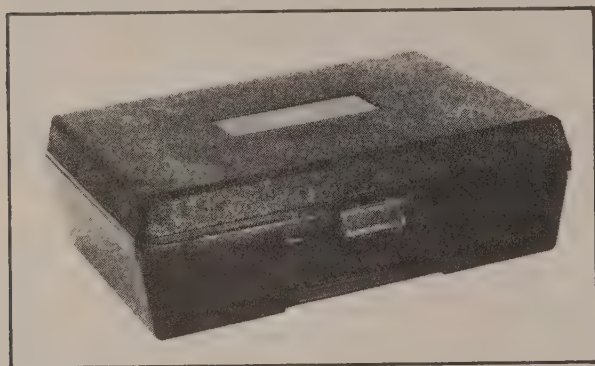


Figure 6-2. C86 CARRYING CASE

6-7. THERMOCOUPLE PROBES

6-8. Three types of thermocouple probe assemblies (J, K and T) are available from Fluke for use with the 2175A. See Table 6-1. Each thermocouple is enclosed in a 6-inch x 1/8 inch iconel sheath, and includes a heavy duty transition splice and spring. See Figure 6-3. The thermocouple junction is grounded to the sheath, and 36-inch trimmed leads are included on all units. Refer to the Tables under Specifications in Section 1 of this manual for the temperature ranges recommended for each thermocouple type.

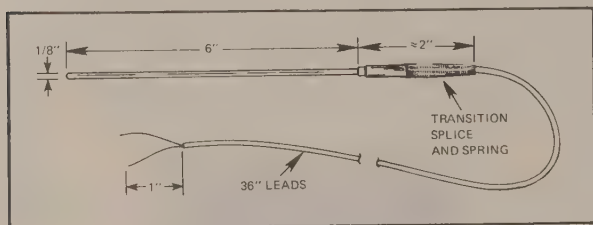


Figure 6-3. P20 SERIES PROBE

6-9. FRONT PANEL DUST COVER (M00-100-714)

6-10. The front panel dust cover is a molded plastic snap-on accessory which fits over the front panel of the 2175A. The dust cover provides protection for the front panel controls, and is useful when storing or transporting the unit.

6-11. RACK MOUNTING KITS

6-12. Three rack mounting kits are available for mounting the 2175A in a standard 19-inch equipment rack. The kits,

listed in Table 6-1, provide the option of either offset mounting (left/right), center mounting or side-by-side mounting.

6-13. TYPE SELECT PCB's

6-14. A series of plug-in type select pcb's are available as accessories to allow the thermocouple compatibility of the 2175A to be changed by the user. The available pcb's are listed in Table 6-1; and the instructions necessary to interchange pcb's in the 2175A are given in Section 2 of this manual under Thermocouple Compatibility. Only one of the pcb's can be installed in the 2175A at any given time.

6-15. BATTERY PACK, OPTION -01

6-16. Battery operation of the 2175A requires the installation of four, rechargeable, D-size, Nickel-Cadmium batteries. These batteries are field installable and are available from the John Fluke Mfg. Co., Inc. as the -01 Option. A charging circuit is included in the basic 2175A to charge the batteries. The batteries receive a trickle-charge during normal operation and a fast-charge when the Charge Mode is enabled. Typically, a fully charged set of batteries will allow 8 hours of portable operation. To fully charge a set of discharged batteries, operate the unit in the ON charge mode for 14 hours at a case temperature below 25°C (77°F). (See paragraph 6-23.)

CAUTION!

The 2175A may be damaged if alkaline, zinc-carbon, or mercury batteries are charged in the unit. Use only Nickel-Cadmium batteries.

6-17. Installation

6-18. Use the following procedure for installing Ni-Cad batteries in the 2175A:

- a. Disconnect line cord. Remove center retaining screw at rear of instrument case, and remove instrument from case.
- b. Remove center bolt and nut from each battery holder.
- c. Remove the top half of each plastic holder.
- d. Orient the battery polarities according to the picture printed on the thermometer pcb (see Figure 4-2).
- e. Reinstall plastic battery holders.
- f. Set LINE-BATT slide-switch to BATT (see Figure 4-2).
- g. Reinstall instrument in case.

6-19. Charging Ni-Cad Batteries

NOTE

Battery manufacturers recommend that Ni-Cad batteries be recharged at least every 90 days. Storage and charging temperatures below +25°C (77°F) are recommended to achieve full charge and 8 hours of portable operation.

6-20. With regard to the charging of Nickel-Cadmium batteries, there are some phenomena which should be considered. For instance, charging Ni-Cad batteries with cell case temperatures above 25°C will cause the cell's charge capacity to decrease. The decrease in capacity is linear from 100% of rated capacity at 25°C to only 60% of rated capacity at 50°C, and as low as 45% at 60°C. Cell case temperatures typically run from 5°C to 10°C above ambient temperature during charging due to heat dissipated by the charging circuit.

6-21. Charge capacity may also be affected by a cell's charging-discharging routine, due to a memory-type phenomenon. For instance, if a Ni-Cad battery pack is used in a daily routine where it is allowed to discharge by only 30% before being fully recharged again, it will eventually become a battery pack capable of delivering only 30% of its rated capacity. To return such a battery pack to its rated capacity, connect an external load which will discharge the battery completely at a rate equal to its capacity divided by 20. For example, a pack of four series-connected 1.2 volt cells having individual capacity ratings of 3.5 ampere hours should be discharged at a rate of $3.5A \div 20 = .175A$. This requires a load resistor of $4.8V \div .175A = 27.5$ ohms (approximate) with a power rating of at least $(4.8V)(.175A) = .85W$. (A 2-watt carbon composition resistor is suitable.)

6-22. Allow the battery pack to discharge for 30 hours, then charge the battery pack at twice the discharge rate for 20 hours. (In the example, the charging rate would be 0.35 amperes at 4.8 volts.) When charging is complete, discharge the pack at the capacity-divided-by-20 rate for 30 hours, then recharge at twice the discharge rate for a period of 20 hours. The battery pack should now be restored to its rated capacity.

6-23. DIGITAL OUTPUT UNIT, OPTION -02

NOTE

The Digital Output Unit is functional only when the 2175A is being operated from line power.

6-24. The Digital Output Unit (Option -02) is a field installable pcb that mounts on the interior of the 2175A and provides a digital output which is equivalent to the displayed measurement data. The digital output is positive-true, TTL compatible and is presented in bcd, character-parallel format. All displayed characters are represented at the output. Output data is solicited by an External Trigger input and valid data is ensured by Busy and Busy outputs.

6-25. External connections to the Digital Output Unit are made through a 34-pin cable which is supplied with the pcb.

6-26. ANALOG OUTPUT UNIT, OPTION -04

NOTE

The Analog Output Unit is functional only when the 2175A is being operated from line power.

6-27. The Analog Output Unit is a field installable pcb assembly which provides the 2175A with a rear-panel analog output voltage proportional to the displayed measurement data. The output voltage is electrically isolated from the 2175A and covers a voltage range of -0.4 to +4V dc. Automatic polarity sensing is provided for both °C and °F measurements to ensure that the polarity of the output voltage agrees with the displayed polarity. Since the analog output terminals are isolated from the 2175A, the output voltage is referenced to the low terminal of the external recording device (voltmeter, strip-chart recorder, etc.).

6-28. External connections to the Analog Output Unit are made through a connector and cable which is supplied with the pcb.

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere	hf	high frequency	(+) or pos	positive
ac	alternating current	Hz	hertz	pot	potentiometer
af	audio frequency	IC	integrated circuit	p-p	peak-to-peak
a/d	analog-to-digital	if	intermediate frequency	ppm	parts per million
assy	assembly	in	inch(es)	PROM	programmable read-only memory
AWG	american wire gauge	intl	internal	psi	pound-force per square inch
B	bel	I/O	input/output	RAM	random-access memory
bcd	binary coded decimal	k	kilo (10^3)	rf	radio frequency
°C	Celsius	kHz	kilohertz	rms	root mean square
cap	capacitor	kΩ	kilohm(s)	ROM	read-only memory
ccw	counterclockwise	kV	kilovolt(s)	s or sec	second (time)
cer	ceramic	lf	low frequency	scope	oscilloscope
cermet	ceramic to metal(seal)	LED	light-emitting diode	SH	shield
ckt	circuit	LSB	least significant bit	Si	silicon
cm	centimeter	LSD	least significant digit	serno	serial number
cmrr	common mode rejection ratio	M	mega (10^6)	sr	shift register
comp	composition	m	milli (10^{-3})	Ta	tantalum
cont	continue	mA	milliampere(s)	tb	terminal board
crt	cathode-ray tube	max	maximum	tc	temperature coefficient or temperature compensating
cw	clockwise	mf	metal film	tcxo	temperature compensated crystal oscillator
d/a	digital-to-analog	MHz	megahertz	tp	test point
dac	digital-to-analog converter	min	minimum	u or μ	micro (10^{-6})
dB	decibel	mm	millimeter	uhf	ultra high frequency
dc	direct current	ms	millisecond	us or μs	microsecond(s) (10^{-6})
dmm	digital multimeter	MSB	most significant bit	uut	unit under test
dvm	digital voltmeter	MSD	most significant digit	V	volt
elect	electrolytic	MTBF	mean time between failures	v	voltage
ext	external	MTTR	mean time to repair	var	variable
F	farad	mV	millivolt(s)	vco	voltage controlled oscillator
°F	Fahrenheit	mv	multivibrator	vhf	very high frequency
FET	Field-effect transistor	MΩ	megohm(s)	vlf	very low frequency
ff	flip-flop	n	nano (10^{-9})	W	watt(s)
freq	frequency	na	not applicable	ww	wire wound
FSN	federal stock number	NC	normally closed	xfmr	transformer
g	gram	(-) or neg	negative	xstr	transistor
G	giga (10^9)	NQ	normally open	xtal	crystal
gd	guard	ns	nanosecond	xtlo	crystal oscillator
Ge	germanium	opnl ampl	operational amplifier	Ω	ohm(s)
GHz	gigahertz	p	pico (10^{-12})	μ	micro (10^{-6})
gmV	guaranteed minimum value	para	paragraph		
gnd	ground	pcb	printed circuit board		
H	henry	pF	picofarad		
hd	heavy duty	pn	part number		

Federal Supply Codes for Manufacturers

00213 Nytronics Comp. Group Inc. Subsidiary of Nytronics Inc. Formerly Sage Electronics Rochester, New York	02660 Bunker Ramo Corp., Conn Div. Formerly Amphenol-Borg Electric Corp. Broadview, Illinois	04946 Standard Wire & Cable Los Angeles, California	06751 Components, Inc. Semcor Div. Phoenix, Arizona
00327 Welwyn International, Inc. Westlake, Ohio	02799 Areo Capacitors, Inc. Chatsworth, California	05082 Replaced by 94988	06860 Gould Automotive Div. City of Industry, California
00656 Aerovox Corp. New Bedford, Massachusetts	03508 General Electric Co. Semiconductor Products Syracuse, New York	05236 Jonathan Mfg. Co. Fullerton, California	06961 Vernitron Corp., Piezo Electric Div. Formerly Clevite Corp., Piezo Electric Div. Bedford, Ohio
00686 Film Capacitors, Inc. Passaic, New Jersey	03614 Replaced by 71400	05245 Components Corp. now Corcom, Inc. Chicago, Illinois	06980 Eimac Div. Varian Associates San Carlos, California
00779 AMP Inc. Harrisburg, Pennsylvania	03651 Replaced by 44655	05277 Westinghouse Electric Corp. Semiconductor Div. Youngwood, Pennsylvania	07047 The Ross Milton Co. South Hampton, Pennsylvania
01121 Allen-Bradley Co. Milwaukee, Wisconsin	03797 Eldema Div. Genisco Technology Corp. Compton, California	05278 Replaced by 43543	07115 Replaced by 14674
01281 TRW Electronic Comp. Semiconductor Operations Lawndale, California	03877 Transistron Electronic Corp. Wakefield, Massachusetts	05279 Southwest Machine & Plastic Co. Glendora, California	07138 Westinghouse Electric Corp., Electronic Tube Div. Horsehead, New York
01295 Texas Instruments, Inc. Semiconductor Group Dallas, Texas	03888 KDI Pyrofilm Corp. Whippany, New Jersey	05397 Union Carbide Corp. Materials Systems Div. New York, New York	07233 TRW Electronic Components Cinch Graphic City of Industry, California
01537 Motorola Communications & Electronics Inc. Franklin Park, Illinois	03911 Clairex Electronics Div. Clairex Corp. Mt. Vernon, New York	05571 Use 56289 Sprague Electric Co. Pacific Div. Los Angeles, California	07256 Silicon Transistor Corp. Div. of BBF Group Inc. Chelmsford, Massachusetts
01686 RCL Electronics Inc. Manchester, New Hampshire	03980 Muirhead Inc. Mountainside, New Jersey	05574 Viking Industries Chatsworth, California	07261 Aumet Corp. Culver City, California
01730 Replaced by 73586	04009 Arrow Hart Inc. Hartford, Connecticut	05704 Replaced by 16258	07263 Fairchild Semiconductor Div. of Fairchild Camera & Instrument Corp. Mountain View, California
01884 Use 56289 Sprague Electric Co. Dearborn Electronic Div. Lockwood, Florida	04062 Replaced by 72136	05820 Wakefield Engineering Inc. Wakefield, Massachusetts	07344 Bircher Co., Inc. Rochester, New York
02114 Ferroxcube Corp. Saugerties, New York	04202 Replaced by 81312	06001 General Electric Co. Electronic Capacitor & Battery Products Dept. Columbia, South Carolina	07597 Burndy Corp. Tape/Cable Div. Rochester, New York
02131 General Instrument Corp. Harris ASW Div. Westwood, Maine	04217 Essex International Inc. Wire & Cable Div. Anaheim, California	06136 Replaced by 63743	07792 Lerma Engineering Corp. Northampton, Massachusetts
02395 Rason Mfg. Co. Brooklyn, New York	04221 Aemco, Div. of Midtex Inc. Mankato, Minnesota	06383 Panduit Corp. Tinley Park, Illinois	07910 Teledyne Semiconductor Formerly Continental Device Hawthorne, California
02533 Snelgrove, C.R. Co., Ltd. Don Mills, Ontario, Canada M3B 1M2	04222 AVX Ceramics Div. AVX Corp. Myrtle Beach, Florida	06473 Bunker Ramo Corp. Amphenol SAMS Div. Chatsworth, California	07933 Use 49956 Raytheon Co. Semiconductor Div. HQ Mountain View, California
02606 Fenwal Labs Div. of Travenel Labs. Morton Grove, Illinois	04423 Telonic Industries Laguna Beach, California	06555 Beede Electrical Instrument Co. Penacook, New Hampshire	08225 Industro Transistor Corp. Long Island City, New York
	04645 Replaced by 75376	06739 Electron Corp. Littleton, Colorado	
	04713 Motorola Inc. Semiconductor Products Phoenix, Arizona	06743 Clevite Corp. Cleveland, Ohio	

Federal Supply Codes for Manufacturers (cont)

08261 Spectra Strip Corp. Garden Grove, California	11726 Qualidyne Corp. Santa Clara, California	13606 Use 56289 Sprague Electric Co. Transistor Div. Concord, New Hampshire	16299 Corning Glass Electronic Components Div. Raleigh, North Carolina
08530 Reliance Mica Corp. Brooklyn, New York	12014 Chicago Rivet & Machine Co. Bellwood, Illinois	13839 Replaced by 23732	16332 Replaced by 28478
08806 General Electric Co. Miniature Lamp Products Dept Cleveland, Ohio	12040 National Semiconductor Corp. Danbury, Connecticut	14099 Semtech Corp. Newbury Park, California	16473 Cambridge Scientific Ind. Div. of Chemed Corporation Cambridge, Maryland
08863 Nylomatic Corp. Norrisville, Pennsylvania	12060 Diodes, Inc. Chatsworth, California	14140 Edison Electronic Div. Mc Gray-Edison Co. Manchester, New Hampshire	16742 Paramount Plastics Fabricators, Inc. Downey, California
08988 Use 53085 Skottie Electronics Inc. Archbald, Pennsylvania	12136 Philadelphia Handle Co. Camden, New Jersey	14193 Cal-R-Inc. formerly California Resistor, Corp. Santa Monica, California	16758 Delco Electronics Div. of General Motors Corp. Kokomo, Indiana
09214 G.E. Co. Semi-Conductor Products Dept. Power Semi-Conductor Products OPN Sec. Auburn, New York	12300 Potter-Brumfield Div. AMF Canada LTD. Guelph, Ontario, Canada	14298 American Components, Inc. an Insilco Co. Conshohocken, Pennsylvania	17001 Replaced by 71468
09353 C and K Components Watertown, Massachusetts	12323 Presin Co., Inc. Shelton, Connecticut	14655 Cornell-Dublier Electronics Division of Federal Pacific Electric Co. Govt. Control Dept. Newark, New Jersey	17069 Circuit Structures Lab. Burbank, California
09423 Scientific Components, Inc. Santa Barbara, California	12327 Freeway Corp. formerly Freeway Washer & Stamping Co. Cleveland, Ohio	14752 Electro Cube Inc. San Gabriel, California	17338 High Pressure Eng. Co., Inc. Oklahoma City, Oklahoma
09922 Burndy Corp. Norwalk, Connecticut	12443 The Budd Co. Polychem Products Plastic Products Div. Bridgeport, Pennsylvania	14869 Replaced by 96853	17545 Atlantic Semiconductors, Inc. Asbury Park, New Jersey
09969 Dale Electronics Inc. Yankton, S. Dakota	12615 U.S. Terminals Inc. Cincinnati, Ohio	14936 General Instrument Corp. Semi Conductor Products Group Hicksville, New York	17856 Siliconix, Inc. Santa Clara, California
10059 Barker Engineering Corp. Formerly Amerace, Amerace ESNA Corp. Kenilworth, New Jersey	12617 Hamlin Inc. Lake Mills, Wisconsin	15636 Elec-Trol Inc. Saugus, California	17870 Replaced by 14140
11236 CTS of Berne Berne, Indiana	12697 Clarostat Mfg. Co. Dover, New Hampshire	15801 Fenwal Electronics Inc. Div. of Kidde Walter and Co., Inc. Framingham, Massachusetts	18178 Vactec Inc. Maryland Heights, Missouri
11237 CTS Keene Inc. Paso Robles, California	12749 James Electronics Chicago, Illinois	15818 Teledyne Semiconductors, formerly Amelco Semiconductor Mountain View, California	18324 Signetics Corp. Sunnyvale, California
11358 CBS Electronic Div. Columbia Broadcasting System Newburyport, Minnesota	12856 Micrometals Sierra Madre, California	15849 Litton Systems Inc. Useco Div. formerly Useco Inc. Van Nuys, California	18612 Vishay Resistor Products Div. Vishay Intertechnology Inc. Malvern, Pennsylvania
11403 Best Products Co. Chicago, Illinois	12954 Dickson Electronics Corp. Scottsdale, Arizona	15898 International Business Machines Corp. Essex Junction, Vermont	18736 Voltronics Corp. Hanover, New Jersey
11503 Keystone Columbia Inc. Warren, Michigan	12969 Unitrode Corp. Watertown, Massachusetts	15909 Replaced by 14140	18927 GTE Sylvania Inc. Precision Material Group Parts Division Titusville, Pennsylvania
11532 Teledyne Relays Hawthorne, California	13103 Thermalloy Co., Inc. Dallas, Texas	16258 Space-Lok Inc. Burbank, California	19451 Perine Machinery & Supply Co. Seattle, Washington
11711 General Instrument Corp. Rectifier Division Hicksville, New York	13327 Solitron Devices Inc. Tappan, New York		19701 Electro-Midland Corp. Mepco-Electra Inc. Mineral Wells, Texas
	13511 Amphenol Cadre Div. Bunker-Ramo Corp. Los Gatos, California		20584 Enochs Mfg. Inc. Indianapolis, Indiana

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20891 Self-Organizing Systems, Inc. Dallas, Texas	28480 Hewlett Packard Co. Corporate HQ Palo Alto, California	43543 Nytronics Inc. Transformer Co. Div. Geneva, New York	70903 Belden Corp. Geneva, Illinois
21604 Buehse Stamping Co. Columbus, Ohio	28520 Heyman Mfg. Co. Kenilworth, New Jersey	44655 Ohmite Mfg. Co. Skokie, Illinois	71002 Birnback Radio Co., Inc. Freeport, New York
21845 Solitron Devices Inc. Transistor Division Riviera Beach, Florida	29083 Monsanto, Co., Inc. Santa Clara, California	49671 RCA Corp. New York, New York	71400 Bussmann Mfg. Div. of McGraw-Edison Co. Saint Louis, Missouri
22767 ITT Semiconductors Palo Alto, California	29604 Stackpole Components Co. Raleigh, North Carolina	49956 Raytheon Company Lexington, Massachusetts	71450 CTS Corp. Elkhart, Indiana
23050 Product Comp. Corp. Mount Vernon, New York	30148 AB Enterprise Inc. Ahoskie, North Carolina	50088 Mostek Corp. Carrollton, Texas	71468 ITT Cannon Electric Inc. Santa Ana, California
23732 Tracor Inc. Rockville, Maryland	30323 Illinois Tool Works, Inc. Chicago, Illinois	50579 Litronix Inc. Cupertino, California	71482 Clare, C.P. & Co. Chicago, Illinois
23880 Stanford Applied Engrng. Santa Clara, California	31091 Optimax Inc. Colmar, Pennsylvania	51605 Scientific Components Inc. Linden, New Jersey	71590 Centrelab Electronics Div. of Globe Union Inc. Milwaukee, Wisconsin
23936 Pamotor Div., Wm. J. Purdy Co. Burlingame, California	32539 Mura Corp. Great Neck, New York	53021 Sangamo Electric Co. Springfield, Illinois	71707 Coto Coil Co., Inc. Providence, Rhode Island
24248 Replaced by 94222	32767 Griffith Plastic Corp. Burlingame, California	54294 Cutler-Hammer Inc. formerly Shallcross, A Cutter-Hammer Co. Selma, North Carolina	71744 Chicago Miniature Lamp Works Chicago, Illinois
24355 Analog Devices Inc. Norwood, Massachusetts	32879 Advanced Mechanical Components Northridge, California	55026 Simpson Electric Co. Div. of Am. Gage and Mach. Co. Elgin, Illinois	71785 TRW Electronics Components Cinch Connector Operations Div. Elk Grove Village Chicago, Illinois
24655 General Radio Concord, Massachusetts	32897 Erie Technological Products, Inc. Frequency Control Div. Carlisle, Pennsylvania	56289 Sprague Electric Co. North Adams, Massachusetts	72005 Wilber B. Driver Co. Newark, New Jersey
24759 Lenox-Fugle Electronics Inc. South Plainfield, New Jersey	32997 Bourns Inc. Trimpot Products Division Riverside, California	58474 Superior Electric Co. Bristol, Connecticut	72092 Replaced by 06980
25088 Siemen Corp. Isilen, New Jersey	33173 General Electric Co. Products Dept. Owensboro, Kentucky	60399 Torin Corp. formerly Torrington Mfg. Co. Torrington, Connecticut	72136 Electro Motive Mfg. Co. Williamantic, Connecticut
25403 Amperex Electronic Corp. Semiconductor & Micro-Circuits Div. Slatersville, Rhode Island	34333 Silicon General Westminster, California	63743 Ward Leonard Electric Co., Inc. Mount Vernon, New York	72259 Nytronics Inc. Pelham Manor, New Jersey
27014 National Semiconductor Corp. Santa Clara, California	34335 Advanced Micro Devices Sunnyvale, California	64834 West Mfg. Co. San Francisco, California	72619 Dialight Div. Amperex Electronic Corp. Brooklyn, New York
27264 Molex Products Downers Grove, Illinois	34802 Electromotive Inc. Kenilworth, New Jersey	65092 Weston Instruments Inc. Newark, New Jersey	72653 G.C. Electronics Div. of Hydrometals, Inc. Brooklyn, New York
28213 Minnesota Mining & Mfg. Co. Consumer Products Div. St. Paul, Minnesota	37942 P.R. Mallory & Co., Inc. Indianapolis, Indiana	66150 Winslow Tele-Tronics Inc. Eaton Town, New Jersey	72665 Replaced by 90303
28425 Serv.-Link formerly Bohannon Industries Fort Worth, Texas	42498 National Radio Melrose, Massachusetts	70485 Atlantic India Rubber Works Chicago, Illinois	72794 Dzus Fastener Co., Inc. West Islip, New York
28478 Deltrol Controls Div. Deltrol Corporation Milwaukee, Wisconsin		70563 Amperite Company Union City, New Jersey	72928 Gulton Ind. Inc. Gudeman Div. Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982 Erie Tech. Products Inc. Erie, Pennsylvania	75382 Kulka Electric Corp. Mount Vernon, New York	80583 Hammarlund Mfg. Co., Inc. Red Bank, New Jersey	83594 Burrhoughs Corp. Electronic Components Div. Plainfield, New Jersey
73138 Bechman Instrument Inc. Helipot Division Fullerton, California	75915 Littlefuse Inc. Des Plaines, Illinois	80640 Arnold Stevens, Inc. South Boston, Massachusetts	83740 Union Carbide Corp. Battery Products Div. formerly Consumer Products Div. New York, New York
73293 Hughes Aircraft Co. Electron Dynamics Div. Torrance, California	76854 Oak Industries Inc. Switch Div. Crystal Lake, Illinois	81073 Grayhill, Inc. La Grange, Illinois	84171 Arco Electronics Great Neck, New York
73445 Amperex Electronic Corp. Hicksville, New York	77342 AMF Inc. Potter & Brumfield Div. Princeton, Indiana	81312 Winchester Electronics Div. of Litton Industries Inc. Oakville, Connecticut	84411 TRW Electronic Components TRW Capacitors Ogallala, Nebraska
73559 Carling Electric Inc. West Hartford, Connecticut	77638 General Instrument Corp. Rectifier Division Brooklyn, New York	81483 Therm-O-Disc Inc. Mansfield, Ohio	84613 Fuse Indicator Corp. Rockville, Maryland
73586 Circle F Industries Trenton, New Jersey	77969 Rubbercraft Corp. of CA. LTD. Torrance, California	81483 International Rectifier Corp. Los Angeles, California	84682 Essex International Inc. Industrial Wire Div. Peabody, Massachusetts
73734 Federal Screw Products, Inc. Chicago, Illinois	78189 Shakeproof Div. of Illinois Tool Works Inc. Elgin, Illinois	81590 Korby Mfg. Co. Seattle, Washington	86577 Precision Metal Products of Malden Inc. Stoneham, Massachusetts
73743 Fischer Special Mfg. Co. Cincinnati, Ohio	78277 Sigma Instruments, Inc. South Braintree, Massachusetts	81741 Chicago Lock Co. Chicago, Illinois	86684 Radio Corp. of America Electronic Components Div. Harrison, New Jersey
73899 JFD Electronics Co. Components Corp. Brooklyn, New York	78488 Stackpole Carbon Co. Saint Marys, Pennsylvania	82305 Palmer Electronics Corp. South Gate, California	86928 Seastrom Mfg. Co., Inc. Glendale, California
73949 Guardian Electric Mfg. Co. Chicago, Illinois	78553 Eaton Corp. Engineered Fastener Div. Tinnerman Plant Cleveland, Ohio	82389 Switchcraft Inc. Chicago, Illinois	87034 Illuminated Products Inc. Subsidiary of Oak Industries Inc. Anahiem, California
74199 Quan Nichols Co. Chicago, Illinois	79136 Waldes Kohinoor Inc. Long Island City, New York	82415 North American Phillips Controls Corp. Frederick, Maryland	88219 Gould Inc. Industrial Div. Trenton, New Jersey
74217 Radio Switch Corp. Marlboro, New Jersey	79497 Western Rubber Company Goshen, Indiana	82872 Roanwell Corp. New York, New York	88245 Litton Systems Inc. Usecos Div. Van Nuys, California
74276 Signalite Div. General Instrument Corp. Neptune, New Jersey	79963 Zierick Mfg. Corp. Mt. Kisko, New York	82877 Rotron Inc. Woodstock, New York	88419 Cornell-Dubilier Electronic Div. Federal Pacific Co. Fuquay-Varian, North Carolina
74306 Piezo Crystal Co. Carlisle, Pennsylvania	80031 Electro-Midland Corp. Mepeco Div. A North American Phillips Co. Norristown, New Jersey	82879 ITT Royal Electric Div. Pawtucket, Rhode Island	88486 Plastic Wire & Cable Jewett City, Connecticut
74542 Hoyt Elect. Instr. Works Penacook, New Hampshire	80145 LFE Corp., Process Control Div. formerly API Instrument Co. Chesterland, Ohio	83003 Varo Inc. Garland, Texas	88690 Replaced by 04217
74970 Johnson E.F., Co. Waseca, Minnesota	80183 Use 56289 Sprague Products North Adams, Massachusetts	83058 The Carr Co., United Can Div. of TRW Cambridge, Massachusetts	89536 John Fluke Mfg. Co., Inc. Seattle, Washington
75042 TRW Electronics Components IRC Fixed Resistors Philadelphia, Pennsylvania	80294 Bourns Inc., Instrument Div. Riverside, California	83298 Bendix Corp. Electric Power Div. Eatontown, New Jersey	89730 G.E. Co., Newark Lamp Works Newark, New Jersey
75376 Kurz-Kasch Inc. Dayton, Ohio		83330 Herman H. Smith, Inc. Brooklyn, New York	
75378 CTS Knights Inc. Sandwich, Illinois		83478 Rubbercraft Corp. of America, Inc. West Haven, Connecticut	

Federal Supply Codes for Manufacturers (cont)

90201 Mallory Capacitor Co. Div. of P.R. Mallory Co., Inc. Indianapolis, Indiana	91836 King's Electronics Co., Inc. Tuckahoe, New York	95354 Methode Mfg. Corp. Rolling Meadows, Illinois	98291 Sealectro Corp. Mamaroneck, New York
90211 Use 56365 Square D Co. Chicago, Illinois	91929 Honeywell Inc. Micro Switch Div. Freeport, Illinois	95712 Bendix Corp. Electrical Components Div. Microwave Devices Plant Franklin, Indiana	98388 Royal Industries Products Div. San Diego, California
90215 Best Stamp & Mfg. Co. Kansas City, Missouri	91934 Miller Electric Co., Inc. Div. of Aunet Woonsocket, Rhode Island	95987 Weckesser Co. Inc. Chicago, Illinois	98743 Replaced by 12749
90303 Mallory Battery Co. Div. of Mallory Co., Inc. Tarrytown, New York	92194 Alpha Wire Corp. Elizabeth, New Jersey	96733 San Fernando Electric Mfg. Co. San Fernando, California	98925 Replaced by 14433
91094 Essex International Inc. Suglex/IWP Div. Newmarket, New Hampshire	93332 Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts	96853 Gulton Industries Inc. Measurement and Controls Div. formerly Rustak Instruments Co. Manchester, New Hampshire	99120 Plastic Capacitors, Inc. Chicago, Illinois
91293 Johanson Mfg. Co. Boonton, New Jersey	94145 Replaced by 49956	96881 Thomson Industries, Inc. Manhasset, New York	99217 Bell Industries Elect. Comp. Div. formerly Southern Elect. Div. Burbank, California
91407 Replaced by 58474	94154 Use 94988 Wagner Electric Corp. Tung-Sol Div. Newark, New Jersey	97540 Master Mobile Mounts, Div. of Whitehall Electronics Corp. Ft. Meyers, Florida	99392 STM Oakland, California
91502 Associated Machine Santa Clara, California	94222 Southco Inc. formerly South Chester Corp. Lester, Pennsylvania	97913 Industrial Electronic Hardware Corp. New York, New York	99515 ITT Jennings Monrovia Plant Div. of ITT Jennings formerly Marshall Industries Capacitor Div. Monrovia, California
91506 Augat Inc. Attleboro, Massachusetts	95146 Alco Electronic Products Inc. Lawrence, Massachusetts	97945 Penwalt Corp. SS White Industrial Products Div. Piscataway, New Jersey	99779 Use 29587 Bunker-Ramo Corp. Barnes Div. Landsdowne, Pennsylvania
91637 Dale Electronics Inc. Columbus, Nebraska	95263 Leecraft Mfg. Co. Long Island City, New York	97966 Replaced by 11358	99800 American Precision Industries Inc. Delevan Division East Aurora, New York
91662 Elco Corp. Willow Grove, Pennsylvania	95264 Replaced by 98278	98094 Replaced by 49956	99942 Centrelab Semiconductor Centrelab Electronics Div. of Globe-Union Inc. El Monte, California
91737 Use 71468 Gremar Mfg. Co., Inc. ITT Cannon/Gremar Santa Ana, California	95275 Vitramon Inc. Bridgeport, Connecticut	98159 Rubber-Teck, Inc. Gardena, California	Toyo Electronics (R-Ohm Corp.) Irvine, California
91802 Industrial Devices, Inc. Edgewater, New Jersey	95303 RCA Corp. Receiving Tube Div. Cincinnati, Ohio	98278 Malco A Microdot Co., Inc. Connector & Cable Div. Pasadena, California	National Connector Minneapolis, Minnesota
91833 Keystone Electronics Corp. New York, New York	95348 Gordo's Corp. Bloomfield, New Jersey		

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Section 8

Schematic Diagrams

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8-6	A3 Type Select PCB Assembly Schematic	2160A-1012	8-6

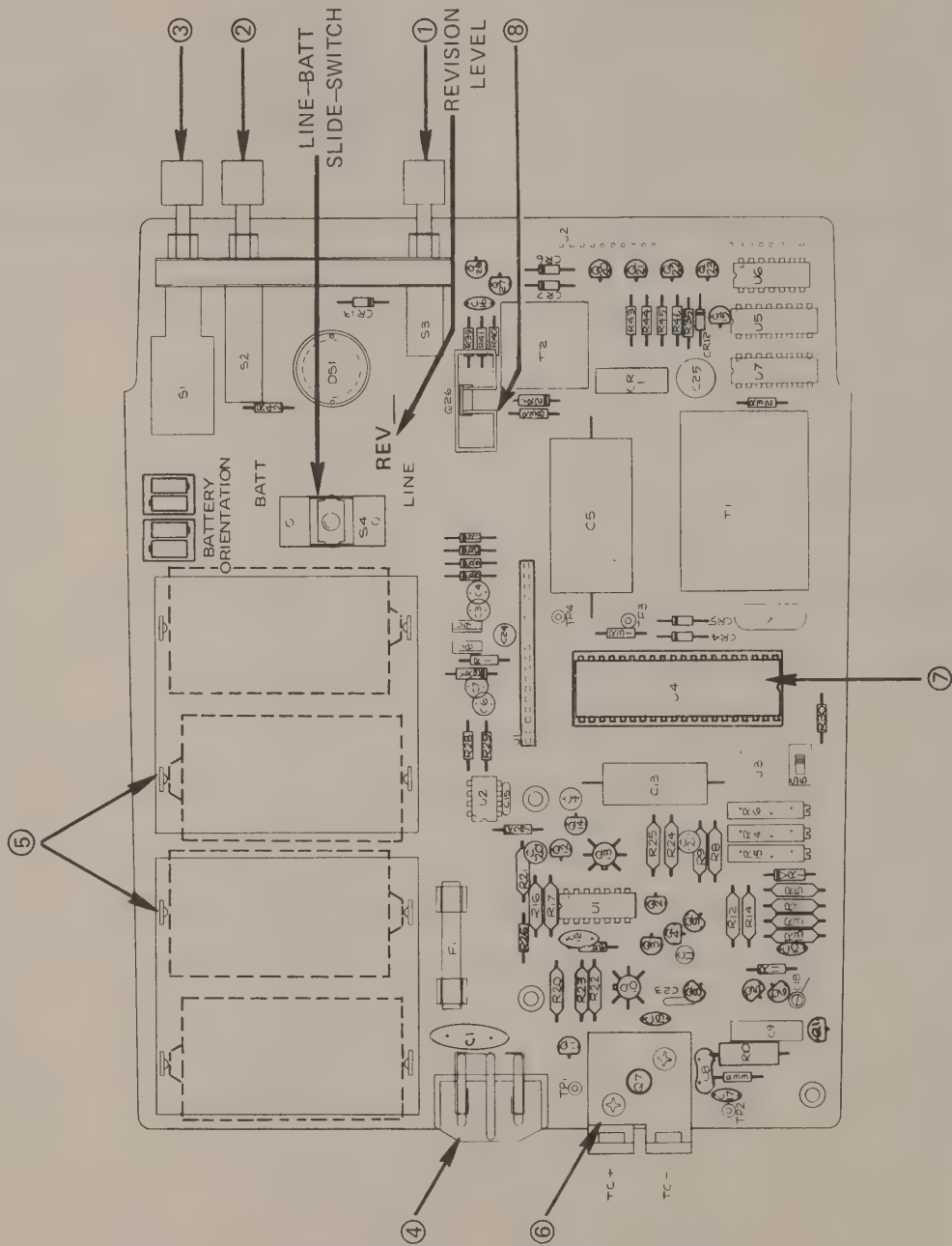


Figure 8-1. A1A1 THERMOMETER PCB ASSEMBLY COMPONENT LOCATION (2175A-1601)

- NOTES
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
 2. ○ INDICATES CALIBRATION ADJUST POINTS. ALL POINTS ARE SCHEMATICALLY ADJUST.
 3. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED.
 4. ALL GRAPHIC SYMBOLS IN ACCORDANCE WITH ANSI 132.14 UNLESS OTHERWISE NOTED.
 5. ▽ DENOTES ANALOG COMMON.
 6. ▴ DENOTES LOGIC COMMON.
 7. // DENOTES CHASSIS COMMON.
 8. FOR ASSEMBLY DRAWING SEE 2175A-4001. CONNECTOR LOCATIONS ARE SHOWN IN THE ASSEMBLY DRAWING. CLOCK GND WITH MARKED GATE IN POSITION SHOWN.
 9. WARNING: ○ INDICATES USAGE OF MOS TRANSISTORS. MOS TRANSISTORS ARE EXTREMELY SENSITIVE TO DISCHARGE. USE SPECIAL HANDLING PER EDT 187.

REF	+	-5	LOGIC COMMON
U7	1	7, 8	

CONNECTOR LOCATIONS
J1 TO P1 ON D011 A01
J2 TO P2 ON DISPLAY
J3 TO P3 ON TYPE SELECT

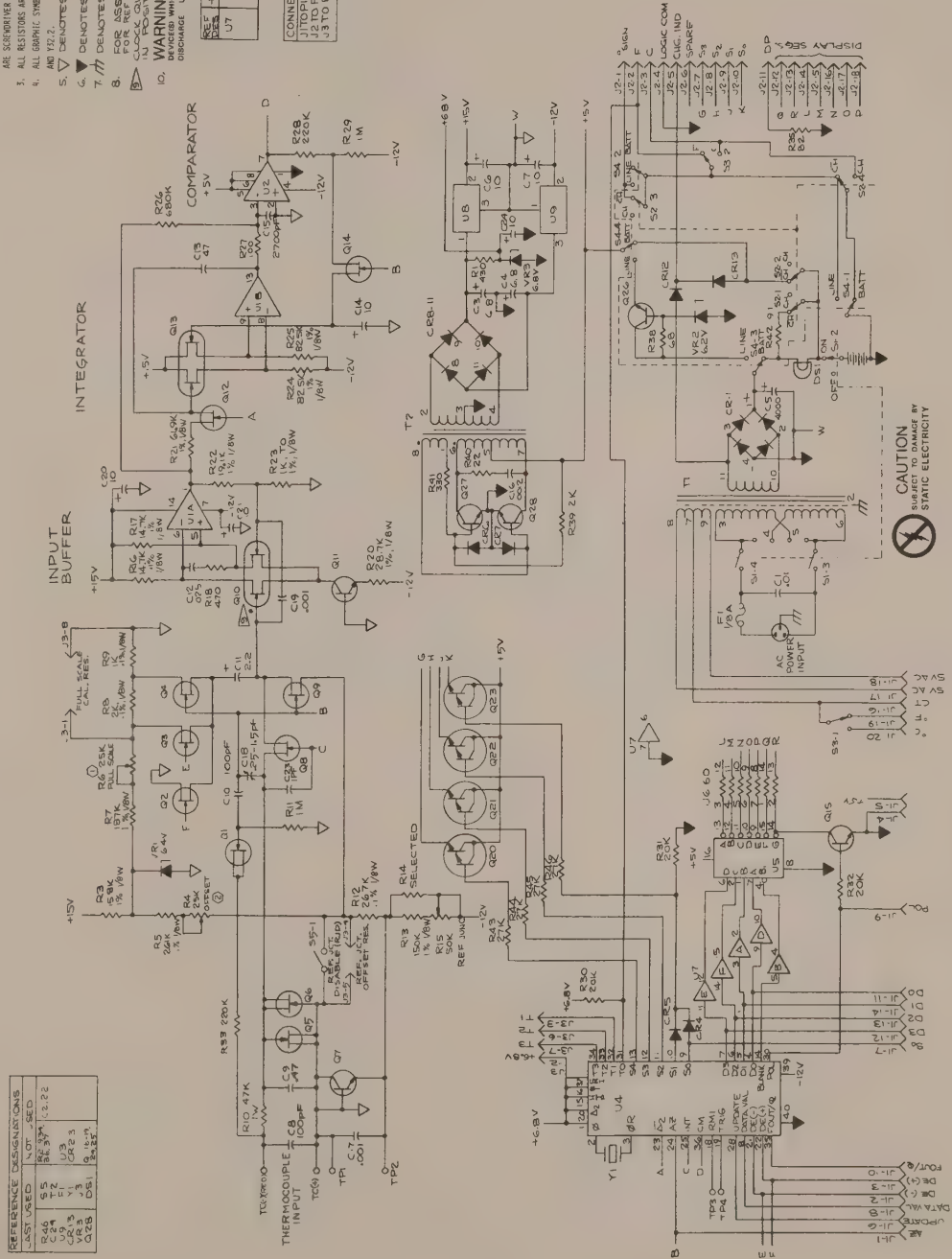


Figure 8-2. A1A1 THERMOMETER PCB ASSEMBLY SCHEMATIC (2175A-1001)

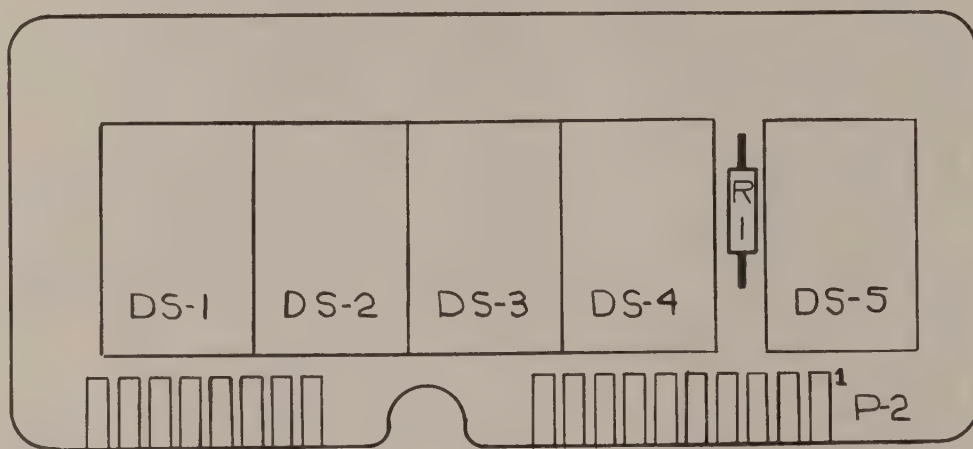


Figure 8-3. A2 DISPLAY PCB ASSEMBLY COMPONENT LOCATION (2165A-1603)

2/77

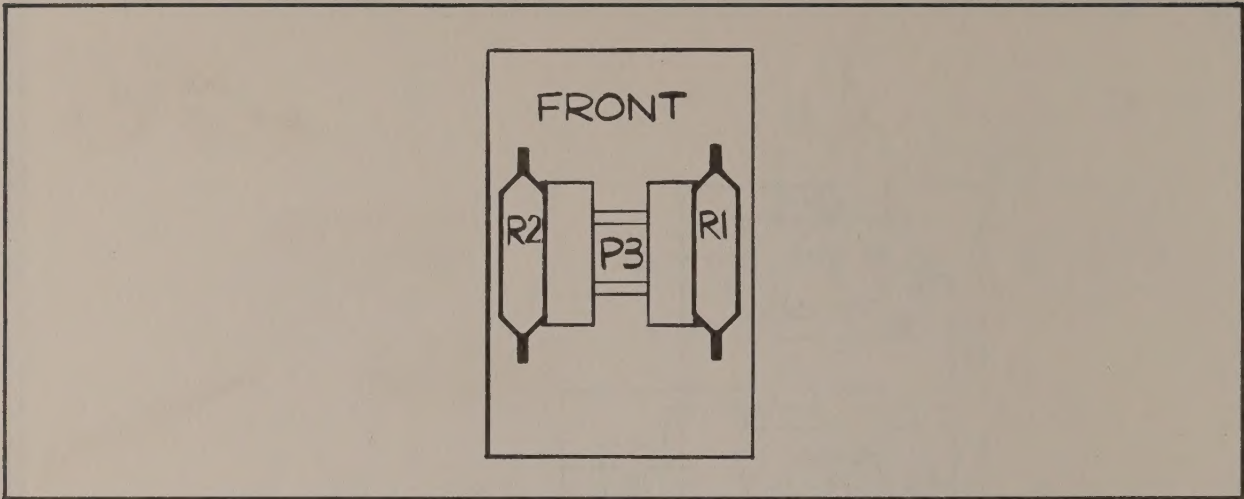


Figure 8-5. A3 TYPE SELECT PCB ASSEMBLY COMPONENT LOCATION (2160A-1612)

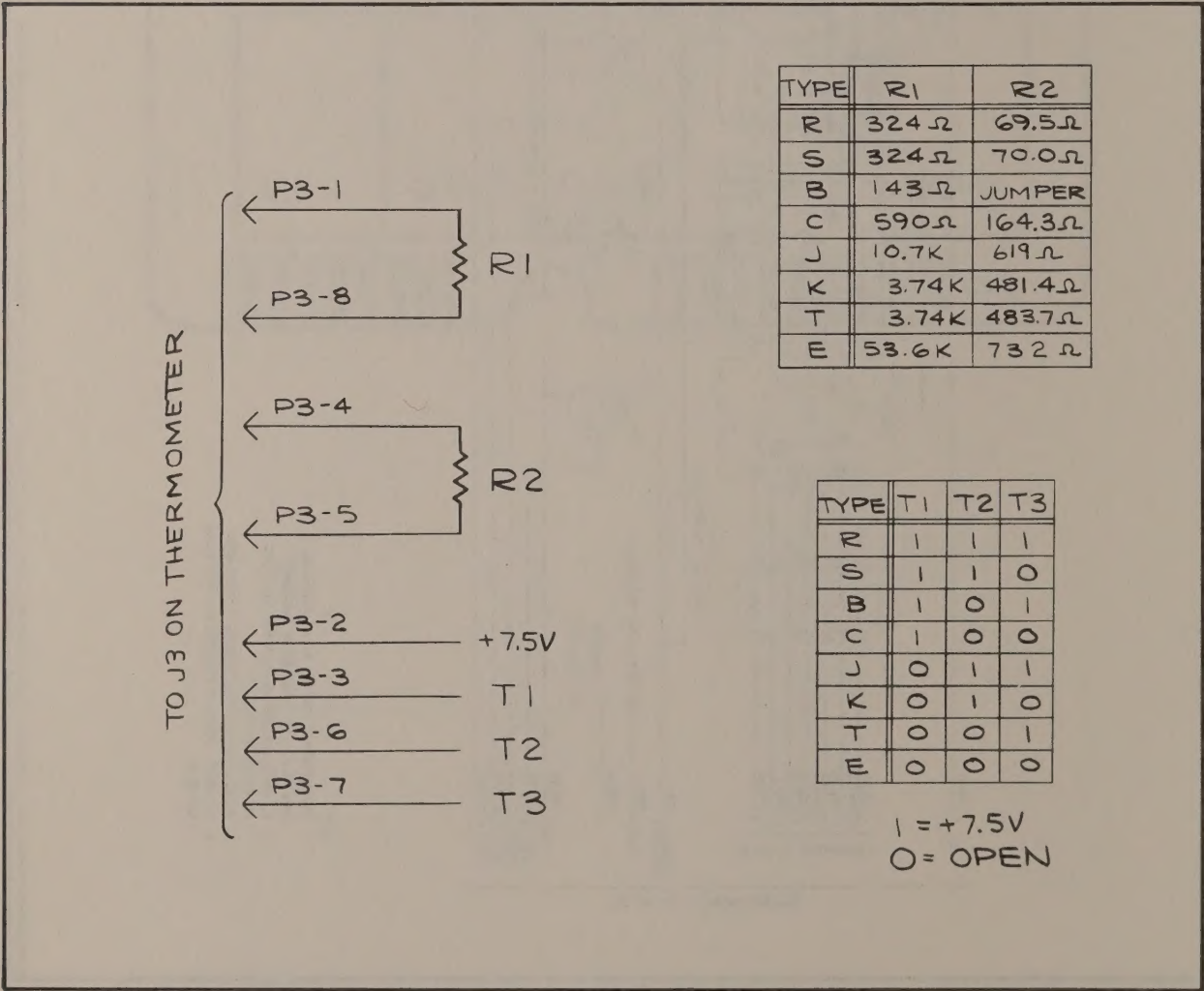


Figure 8-6. A3 TYPE SELECT PCB ASSEMBLY SCHEMATIC (2160A-1012)

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